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GEOLOGICAL SURVEY OF ILLINOIS.

A. H. WORTHEN, DIRECTOR.

VOLUME II.

PALÆONTOLOGY.

DESCRIPTIONS OF VERTEBRATES.
BY J. S. NEWBERRY AND A. H. WORTHEN.
DESCRIPTIONS OF INVERTEBRATES.
BY F. B. MEEK AND A. H. WORTHEN.
DESCRIPTIONS OF PLANTS.
BY LEO LESQUEREUX.

ILLUSTRATED
BY THE WESTERN ENGRAVING COMPANY, CHICAGO
PUBLISHED
BY AUTHORITY OF THE LEGISLATURE OF ILLINOIS.
1866.

L. W. SCHMIDT, NEW YORK.

STATE JOURNAL STEAM PRESS, SPRINGFIELD, ILL.

INTRODUCTION.

It is well known to Geologists that life did not first burst into existence in the forms of plants and animals we now see around us. On the contrary, there were many successive steps in the great work of creation: the organisms of one period, after subserving the ends for which they were called into existence, passing gradually away, to give place to new types, which in their turn became extinct. Although there were partial exceptions to the general rule, each successive fauna and flora (using these terms in their widest signification) presented, on the whole, an improvement upon the preceding; or, in other words, the first created forms were amongst the most simple in structure, and hence the lowest in the scale of life; while those that came after, as time passed on, were more and more highly organized, until at last MAN, the highest type of all, appeared to exercise dominion over all existing beings.

During these long ages and cycles of the past, the earth itself was undergoing many mutations, both from the action of internal igneous forces, and external agencies. Islands and continents were rising above or sinking beneath the ocean level; mountain chains were being upheaved and vast areas were alternately submerged, and again raised above the level of the sea, to be occupied by immense marshes, supporting dense growths of strange trees, shrubs and herbaceous plants, which, by their death and accumulation through long periods of time, formed the material of our coal beds. During all this time, solid rocks, where exposed, were, as at present, slowly crumbling under the disintegrating influences of rains, frosts and other atmospheric agencies, to be swept by streams into seas, estuaries and lakes, to form beds of sand, clay or marl, or to be consolidated into rocky strata, which, as time rolled on, were again raised to form plains, hills and mountain chains, subject to the same ceaseless round of destruction and re-formation to which they owed their origin.

But the materials of which even our hardest stratified rocks are composed were not, in every instance, entirely and *directly* derived from the wreck of pre-existing solid rocks, for there was some working over of the same materials, without the action of the intervening process of consolidation; and the remains of corals, crinoids, shells, and other marine organisms, often contributed much the larger portion of the substances composing marine strata, while in other instances the remains of land and fresh-water animals and plants, carried in by streams, form considerable portions of extensive estuary and lacustrine formations. Hence, as the animals and plants of each of the great epochs, although mainly different from those of the preceding and following ages, presented, with occasional exceptions, a remarkable general similarity during each individual period, over the entire globe, their fossil remains furnish the Geologist an unerring guide in the identification of strata, and the determination of their position in the series, as well as of their relative ages. As the learned Antiquary determines the age and history of some ruined city, in regard to which both written and traditional history are silent, by a careful study of the inscriptions upon its walls, or of the seals, coins, medals, etc., found amongst its rubbish, so does the skillful Palæontologist determine the period of the earth's history to which an outcrop or stratum of rock belongs, and its place in the geological series, by inspecting its imbedded organic remains.

When it is therefore borne in mind, that coal and other valuable minerals were not indiscriminately distributed through the earth, but were mainly formed or deposited, at least in quantities and under conditions to be useful to man, during particular geological periods, the importance of knowing to what epoch of the earth's history the rocks of any given district belong, before undertaking mining enterprises of any kind, will be readily understood, and the intelligent general reader will at once comprehend why it is that geologists give so much attention to fossils. In short, the first and most important step in the prosecution of a geological survey, is a careful and thorough study and investigation of the organic remains found in every seam and stratum of the rocks of the district to be explored; for without a knowledge of these, all conclusions in regard to the geological structure of the country, or of the age and position in the geological column of its rocks, must necessarily be vague and unreliable. Indeed, without the aid of Palæontology, Geology would scarcely be entitled to rank as a science at all.

But aside from all mere utilitarian considerations, there is much in the history of these mute relics of by-gone ages—extending, as it does, deep into the mysterious past, and revealing, as it were, glimpses of the successive steps in the great work of creation itself—that must ever render them objects of the most profound interest to all reflecting minds. When it is remembered, too, that the rocks of our State are unusually rich in these interesting remains (to a great extent new to science), we can scarcely be mistaken in supposing that the citizens of the great State of Illinois will feel a commendable pride in contributing their share to the general stock of knowledge, in a department of science now claiming so much attention from enlightened minds throughout the civilized world. Nor can we believe the people of Illinois desire that the students of our schools and colleges, and others, justly ambitious to keep pace with the great minds of other lands, in every department of learning, should be longer dependent upon reports published by our neighboring States for a knowledge of these wonderful works of the Creator, so profusely scattered at our feet, even if it were possible to find the desired information there. Hence we think any extended statement of the motives that have induced us to give the necessary attention to this department of the survey, would be uncalled for, and out of place here.

In the preparation of this volume on the Palæontology of the survey, it will be observed that almost exclusive attention has been given to the organic remains of the Carboniferous rocks. This has been done, first, because the most important stores of mineral wealth found within the limits of the State, occur in these rocks; second, because they occupy far the larger portion of its area; and third, because these strata contain more organic remains, entirely new to science, than any of our other formations. In a part of a succeeding report, however, now in an advanced state of preparation, it is intended, should the Legislature make an appropriation for its publication, to give figures and descriptions of enough of the characteristic fossils of the other formations to give completeness to the whole, and afford students and intelligent miners the means of determining to what geological period the rocks at any outcrop belong, in any part of the State to which their attention may be directed. It will not, however, be necessary to occupy so much space, in any future report, with figures and descriptions of fossils, as was required here in laying, as it were, a foundation for the whole work.

It will be observed that, in a few instances, we have figured and described fossils from adjoining States. This, however, has only been done where the same formations occur in Illinois, but have not yet afforded us as perfect specimens of the particular species as those obtained at localities outside of the State.

The fact that this volume consists of several distinct memoirs, prepared by parties working to a considerable extent independently, has prevented that degree of uniformity, in the plan of the whole, that would otherwise have prevailed. As each section, however, treats upon a different department of Palæontology, and a list of all the species is given at the end of this Introduction, arranged by formations and in accordance with their affinities, as far as they go in each rock, without regard to their distribution in the several memoirs, little inconvenience can arise from the want of a more systematic arrangement of the contents of the volume.

In the portion of the work devoted to the description of the Vertebrates, the species are described much in the order that the figures were most conveniently arranged and numbered on the plates, and not always in accordance with their zoological or geological relations; though the locality and position of each species is mentioned at the end of its description, and a systematic synopsis of the species is given at the close of the memoir.

The Invertebrates, excepting the *Polyzoa* (which are all described together in a supplementary paper), are described in the order of their geological succession, and arranged zoologically, as far as they go in each formation. The fossil plants are also, like the *Polyzoa*, described together in a separate section, mainly in the order of their botanical relations. The geological position and locality of each species, however, is mentioned in connection with its description.

The whole number of species of all kinds, illustrated and described, is about 325, of which nearly 300 were discovered or first made known to science through the agency of the Illinois Geological Survey. Of these 325 species, 50 are plants, 156 Invertebrate animals, and 119 Vertebrates. Altogether they represent 115 genera, 25 of which have been established by parties connected with the survey. Of these genera 18 are plants, 67 Invertebrates, and 30 Vertebrates—the latter of which, with one exception (a *Batrachian*), being all fishes. Of the 115 genera represented, 81 are more or less fully characterized, and most of them illustrated in this volume.*

The various rocks from which these fossils were obtained having been described, and their relations fully discussed, in the first volume of this Report, it would be superfluous to enter into any extended remarks on that subject here; but for the convenience of those not familiar with our geology, who may use this volume without always having the other directly at hand, the following section, showing the order of succession, maximum thickness, etc., of the strata of this State, is given:

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* As no other single volume of Palæontology, hitherto issued in this country, contains so large a number of generic descriptions, and as most of these descriptions, even of previously established genera, have been carefully rewritten, and more or less modified from the study of extensive collections of specimens, it is hoped that this feature of the Report will add materially to its value and usefulness, especially to students who may not have access to extensive libraries of works on Palæontology.

ILLINOIS ROCKS.				FEET.
Post-Tertiary			Drift, Loess, etc.—Clay, sand, pebbles, boulders, etc.	150
Tertiary		Eocene period?	Clays and greenish sand	150
Carboniferous System	Upper	Carboniferous period.	Coal Measures and Millstone grit. } Coal, shale, clay, limestones, sandstones and conglomerate	1200
	Lower	Mountain limestone or Subcarboniferous period.	Chester group.—Limestone, sandstone and shale	800
			St. Louis beds.—Limestone and shale	200
			Keokuk group.—Limestone and shale	150
			Burlington group.—Coarse, subcrystalline limestone	200
			Kinderhook group.—Shales, limestone, sandstone, etc.	150
Devonian System		Hamilton period	Genesee division.—"Black slate" and grayish shale	100
			Hamilton beds. { Dark grayish, fœted and lighter, more pure limestones	120
		U. Helderb. period.	Cornif. and Onondaga beds.—Gray, more or less sandy limest.	25
		Oriskany period	Oriskany—upper bed.—Quartzose sandstone	40
			Oriskany—lower beds, or Clear-creek group. } Highly silicious, very cherty magnesian limest., usually in thin layers	200
Silurian System	Upper	Lower Helderberg period.	Lower Helderberg group, (D. shaly limest. of N. Y. Geologists) } More or less magnesian and argillaceous limest., in thin layers, including flinty concretions	200
		Niagara period	Niagara group.—Magnesian and argillaceous limestones	200
	Lower	Cincinnati period	Cincinnati group.—Limestones, shales and sandstone	140
		Trenton period	Galena and Trenton beds. { Magnesian, and more or less pure limestones	300
		Potsdam or Primordial period.	St. Peters division.—Pure quartzose sandstone	150
			Calciferous division.—Magnesian limestones and sandstones.	120 seen.

In regard to the nomenclature used for the rocks represented in the foregoing section, as well as respecting some modifications made in the same since the publication of the first volume of this Report, it may be proper to add some remarks. In the first place, it will be observed that we have (with a few exceptions, to be mentioned farther on), retained the names by which these formations are most generally known. In doing so, however, we have dropped the words "sandstone," "limestone," etc., as parts of these names, and substituted the words "group," "division," or "beds," in those names in part derived from lithological characters. Names of the latter kind, or those suggested by the presence of some particular species or genus of fossils at the localities where rocks were first studied, are, from the instability of such characters, often found extremely inapplicable, when we attempt to trace strata far from the original localities. For this reason, and their consequent liability to mislead the student, there is a growing disposition amongst the highest authorities in geology to drop the objectionable parts of such names, and retain only those portions of the original names derived from the typical localities. In this connection, we need only refer to such works as Prof. DANA's Manual of Geology, and Sir WILLIAM LOGAN's Report on the Progress of the Canadian Geological Survey, published in 1863.

For the lowest division of the Subcarboniferous series, we have used the name *Kinderhook group*, provisionally proposed by us, in 1861, for a group of arenaceous and more or less calcareous strata, at the base of the Subcarboniferous, that had been referred by Prof. HALL, and some others, to the Chemung group of the New York series, very generally regarded as belonging to the Devonian system. Being unable to identify a single Chemung species amongst all our collections from this horizon, and finding them, as a group, decidedly more nearly allied to Carboniferous forms, as well as, in some instances, undistinguishable from species in the Carboniferous limestones above, we proposed for this formation the name *Kinderhook group*, from its development at the village of that name in Pike county, of this State—stating, at the same time, that we could no longer view it as the equivalent of the Chemung, and that we regarded it as being more intimately related to the Carboniferous above, than to the Devonian below. It is proper that we should state here, that this opinion was also previously maintained by M. DE VERNEUIL, Dr. NORWOOD and Dr. OWEN, as well as some others.

At the time we proposed the name Kinderhook group for this formation, little was known in regard to its relations to some similar deposits Prof. WINCHELL had called the Marshall group, in Michigan, and to what the Ohio geologists had designated as the Waverly sandstone, in Ohio. Since then, however, we have traced this rock into Northern Ohio, and ascertained, beyond doubt, that it is the same as the Waverly sandstone, or at any rate, as the only portion (the upper part) of that series in which we succeeded in finding fossils. Prof. WINCHELL, who concurs in the opinion that these beds belong to the Carboniferous, has also since identified his Marshall group with the Waverly sandstone. It is therefore probable that the oldest name—Waverly sandstone, or more properly, *Waverly group*—will have to be adopted for this formation. Until all questions in regard to the exact parallelism of these deposits, as developed in the several States alluded to, can be cleared up, however, by farther investigations, it will be better to retain the local names by which they are now known in the States mentioned.

In the first volume of this Report, just published, on the general geology of Illinois, the name "*Clear creek limestone*" was provisionally used for a series of strata holding a position, in Union and some of the adjoining southern counties, between the so-called Hudson river group of the Lower Silurian, and a Devonian sandstone that had been identified with the Oriskany sandstone of New York. Formerly, when only a few imperfectly preserved fossils were known from these beds below the sandstone mentioned above, they were regarded as most probably belonging mainly, if not entirely, to the Upper Silurian epoch. During the progress of the detailed county surveys of that region, however, Mr. **ENGELMANN** found a few additional fossils, at different horizons above the middle of this doubtful series, which were submitted for examination, and found to indicate that at least a considerable portion of these beds are more nearly allied to the Oriskany sandstone than to the Upper Silurian. The fact, however, that the few specimens, with one exception, then obtained in a condition to be identified, were found to belong to species that are known to be, in New York or Canada, common both to the Oriskany formation and the Lower Helderberg group, left it still a matter of doubt, without farther examinations and the additional collections of fossils, at what precise horizon in this series the line should be drawn between the Devonian and the Upper Silurian. Consequently the whole group between the two horizons mentioned above was, in the first volume, designated as the "*Clear-creek limestone*," with the statement that the line between the Upper Silurian and Devonian should probably be drawn somewhere through this group.

Wishing, if possible, to clear up this doubtful point, we availed ourselves of a short, unavoidable delay in the progress of the printing of this volume on Palæontology, to spend a few days in examining these rocks in Union county, and some of the adjoining portions of Missouri. As the lower portion of this doubtful series seems to be nearly destitute of fossils in Illinois, we directed our attention first to outcrops of these beds on the opposite side of the Mississippi, in Perry county, Missouri, where they were already known to be fossiliferous. At a point a little below Bailey's Landing, in Perry county, we collected a number of fossils, clearly establishing the fact that the whole thickness, of over two hundred feet, exposed there, belongs to that portion of the Upper Silurian forming the "Shaley limestone" division of the Lower Helderberg group, to which Dr. SHUMARD had correctly referred these beds in the Missouri Report. Among the fossils collected by us here, there are forms we cannot distinguish from the following New York "Shaley limestone" species, viz: *Orthis subcarinata* and *O. oblata*, Hall; *Cœlospira concava* and *C. imbricata*, Hall; *Spirifer perlamellosus*, Hall; *Platyceras spirale*, Hall; *P. Gebhardi* and *Acidaspis hamatus*, Conrad. We also found there species scarcely, if at all, distinguishable from the "Shaley limestone" species, *Merista princeps*, *Platyceras pyramidatum*, *P. unguiforme*, *P. incile* and *P. multistriatum*, Hall.

Farther down the river, in the southern part of Perry county, Missouri, the hills, for over two hundred and fifty feet in height, are composed of the same beds seen at Bailey's Landing, and the cherty beds we now include as a part of the Oriskany group, all dipping to the eastward. We found only a few fragments of fossils here, however—barely enough to assure us of the identity of the strata.

On crossing over into Union county, Illinois, in the region of Jonesboro', we had an opportunity to examine the cherty beds alluded to above, and found them characterized (with the exception of *Platyceras Gebhardi*) by an entirely different group of fossils from those seen near Bailey's Landing, and still farther confirming the conclusion that these beds belong to the Oriskany period. Including those collected by Mr. ENGELMANN, and a few that were collected by one of us from these beds in Jackson county, together with those found during our late examinations, we can safely give the following list of well-known Oriskany species, as occurring in this formation in Southern Illinois, namely: *Leptocœlia flabellites* (sp.), Conrad; *Leptæna? nucleata*, *Rhynchonella speciosa* and *Platyceras tortuosum*, Hall; with *Eatonia peculiaris* and *Platyceras Gebhardi*, Conrad. These are associated with *Rensselœria Condoni*, McChesney, which, if not identical with the New York Oriskany species, *R. ovalis*, of Hall, is certainly a very closely allied representative species; also, with several undetermined species of *Spirifer*, some of which are nearly related to *S. arctus*, Hall, and *S. arenosus*, Conrad, from the New York Oriskany: and a *Stricklandiana*, we have not been able to entirely satisfy ourselves is distinct from *S. elongata* (=*Pentamerus elongatus*), Vanuxem. In New York, *S. elongata* is characteristic of the higher Onondaga limestone of the Upper Helderberg, but in Canada it is common to that position and the Oriskany sandstone.

Judging from such an assemblage of fossils as this, and the entire absence, so far as yet known, of any species in these beds *peculiar* to any lower horizon (although *Platyceras Gebhardi* and *Eatonia peculiaris* are, in New York, common to the "Shaley Limestone" division of the Lower Helderberg group and the Oriskany), we cannot resist the conclusion, that a considerable portion of the cherty limestone forming the upper part of the Clear-creek series, as first understood, belongs to the Oriskany period, and that the line between the Upper Silurian and the Devonian, of this region, should be drawn between these cherty beds and the strata below, equivalent to those from which we collected the Lower Helderberg fossils at Bailey's Landing. Exactly how far down in the series this line should be carried we are unable to say, as we found no abrupt lithological change, and we saw no fossils near the horizon of the probable junction. From all the facts, however, we are led to believe that possibly as much as two hundred feet, and perhaps more, of these beds should be included in the Oriskany.

In the sandstone immediately overlying the cherty beds, near Jonesboro', Union county, we found the following fossils (or more properly their moulds—the fossils themselves being, in all cases, dissolved out so as to leave empty cavities), viz: A small *Zaphrentis, Pleurodictyum problematicum*, Goldf.; an *Orthis* like

O. musculosa, Hall, but smaller; a finely striated *Strophodonta*, having the form and general appearance of *S. magnifica*, Hall, but also of smaller size; the same *Stricklandiana* so abundant in the cherty beds below; and fragments of one of those curious types of *Dalmania?* for which Mr. CONRAD proposed the generic name *Odontocephalus*, but much larger than the well known *O. selenurus*, from the Upper Helderberg limestone—being probably not less than six inches in length, when entire. The presence in this bed of this type of *Trilobites*, and the coral *Pleurodictyum problematicum*, which, according to M. DE VERNEUIL, occurs in Indiana associated with well known Corniferous and Onondaga fossils, leads us very strongly to suspect that it will be found to belong more properly to the Upper Helderberg series, with which, as developed here, it also agrees more nearly, in its lithological characters, than to the rocks below; but as the associated *Brachiopoda* seem rather to indicate relations to the underlying cherty beds, we have concluded to place it provisionally as an upper stratum of the Oriskany, until a larger number of species can be obtained from it for study.

Directly overlying the above mentioned sandstone, there is to be seen, at various places in Union and some of the neighboring counties, a light-grayish, very hard, semi-crystalline, often sandy, massive limestone, sometimes passing into alternating beds of limestone and quartzose sandstone. The fossils found in this formation are the following, viz: Very large, exceedingly thin-jointed crinoid columns, *Centronella hecate*, Billings; *Spirifer acuminatus*, Con. (=*S. cultrijugatus*, Roemer); several undetermined Spirifers, greatly extended on the hinge line; *S. fimbriatus*, Conrad? *Atripa reticularis*, Linn.; a small *Productus*, like *P. subaculeatus*, Murchison, but apparently more distinctly costated; *Platyceras dumosum*, Conrad; and another species of the curious type of *Trilobites*, mentioned as occurring in the sandstone beneath, but smaller and more nearly like the

the New York Corniferous species, *Odontocephalus selenurus* of Conrad.

From this group of fossils, geologists will readily understand that we have here a representation of the Upper Helderberg series, probably consisting of a blending of the Corniferous and Onondaga beds of the New York geologists. Consequently we have added this formation, which had not been previously identified in our State, to the Illinois section.

Above the Upper Helderberg rocks, just mentioned, we have the Hamilton beds proper, well marked by characteristic fossils; and over these, the Genesee division of the Hamilton group (="Black slate" of western geologists), which latter is succeeded by the Kinderhook and other Subcarboniferous rocks.

In selecting names for the New York rocks, the surveyors of that State very properly named each formation after the locality where it is best developed; the expressed object being, according to Prof. HALL, "to give the name from the locality which afforded the most complete and extensive exhibition of the strata composing the group." Hence the great series of shales and argillaceous sandstones, so extensively developed along the Hudson river, above the Highlands, was called the "Hudson river group." With the exception of Graptolites, few fossils had been found in these rocks, though in a few little isolated outliers, occupying synclinal axes, somewhere in the region of the Hudson river, supposed to belong to this group, and now said by Prof. HALL to be "of insignificant extent," specimens of *Leptæna sericea*, *Orthis testudinaria*, *Asaphus* and *Trinucleus* had been found. From this latter fact, beds then known by the local names Pulaski shales and sandstone, Lorraine shales, etc., containing these and other fossils (as well as the associated Utica slate), and holding a position above the Trenton group, at localities farther west in New York, were by the New York geologists referred to the Hudson river group, which they consequently placed above the Trenton in their columnar series.

The equivalents of these shales, etc., in the western States, were also, for the same reasons, referred to the Hudson river group.

The discoveries of the last few years, however, chiefly made by the Canadian Geological Survey, have gradually developed the fact that the New York geologists (excepting Dr. EMMONS*) had made a great mistake in placing the true Hudson river rocks above the Trenton: or in other words, that these rocks are older than the Trenton, and belong to the Primordial zone of Barrande. Consequently the slates and shales alluded to farther west, in New York, and their equivalents in the western States, cannot be properly referred to the Hudson river group. In a note on this subject, published in the Report of the Wisconsin Survey (pages 443 to 445), Prof. HALL, after speaking of the great number of Primordial types of fossils found in the Hudson river group in Canada, and some of the adjoining States, within a few years past, makes the following remarks:

* * * "We are therefore satisfied, from the geological relations of the great mass of these rocks, and from the contained organic remains, that they are of older date, and that the fossils of newer age occurring in limited localities should not be regarded as characterizing the formation; that the great mass ot the Hudson river rocks, in their typical localities, are older than the *Lorraine shales and sandstones of Pulaski*, etc.; and that the term *Hudson river group* cannot be properly extended to these rocks, which, on the west side of the Hudson river, are separated from the *Hudson river group, proper*, by a fault not yet fully ascertained."

"There can be no propriety," he continues, "in transferring the name *Hudson river group* from its typical locality, and applying it to rocks we now know to be of younger age, and which, when the sequence is complete, are separated from the Hudson river rocks by a great limestone formation."

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* It is well known that Dr. EMMONS had long maintained, against a vigorous and not always over courteous opposition, that the Hudson river group proper holds a lower stratigraphical position than had been assigned it by his collaborators of the New York Survey.

"I have therefore," he goes on to say, "dropped the term Hudson river group, in its application to the rocks of Wisconsin which are of the age of the Lorraine shales of New York and the Blue limestone group of Ohio."

For the reasons thus clearly stated, he denominates this group, on pages 47 to 56 of the Wisconsin Report, quoted above, simply as the "*Green and Blue shales and limestones*," stating there, also, in another note on page 47, that the term Hudson river group had been improperly extended so as to include the beds of this age west of the Hudson river, and could "no longer with propriety be applied to these western rocks."

Perfectly concurring in this opinion, and being equally well satisfied that such a descriptive phrase as the "*Green and Blue shales and limestone*" could not be retained, in geological nomenclature, as a *name* for a great formation, widely extended in the United States and Canada, under various aspects of color and composition, we felt greatly at a loss for a convenient name for this group. As the local names Utica slate, Lorraine shales, etc., had been originally applied, and long in general use, for subdivisions of this formation for which it is convenient and necessary to have separate names, when we wish to speak with precision of these subordinate rocks, they will of course always be associated, in the minds of geologists, with the beds in connection with which they have been so long used; consequently none of them could, without creating confusion, be extended to the whole group. The term "Blue limestone," long since used for this group by the Ohio geologists, is open to the same objection as that used in the Wisconsin Report, being equally derived from such unstable characters as mere color and composition. Nor could we retain Prof. ROGERS's term "Matinal," nor Prof. SAFFORD's name "Nashville group," for the reason that they were each originally applied to, and since used for, a series including both the Trenton and the so-called Hudson river groups, and hence could not be used when we wish to speak of the group under consideration as a distinct formation from the Trenton.

In order to have a convenient name for this formation, that would be applicable wherever and under whatever lithological characters it might be found, and at the same time mean this particular group—neither more nor less—we proposed, in a paper published in the Proceedings of the Philadelphia Academy of Sciences, August, 1865, p. 155, to call it the *Cincinnati group*, now retained in the accompanying section, and used in the first volume of this Report. We do not think it would be possible to select a more appropriate name than this, Cincinnati being widely known as one of the great commercial cities of the west, while the formation named is perhaps more extensively developed and exposed there than at any other place, and is at the same time so highly fossiliferous at that locality, that its characteristic fossils have been widely distributed, by local and traveling geologists, almost throughout the civilized world. Hence when we speak of the "Cincinnati group," geologists will everywhere know exactly to what horizon we refer, without a word of explanation.

After reading the quotations we have made from the Wisconsin Report, it will be readily understood that one of the writers, on exhibiting a section of the Illinois rocks before the American Association for the Advancement of Science, at the late Buffalo meeting, was not a little surprised that Professor HALL should object to the term Cincinnati group, and insist upon retaining for this formation the name Hudson river group, on the ground *that it is represented on the Hudson river by the isolated masses or outliers already alluded to.* That geologists will, however, sanction such a transfer of the name of a great geological formation from the group to which it was originally applied, and for which alone it is acknowledged to have been intended, to another group, simply because there happens to be a few patches of the latter, of "insignificant extent," in the same region, we cannot believe. Such a misnomer would impose upon the student the perplexing confusion of ideas resulting from the necessity of having always to bear in mind that the *Hudson river rocks*, so greatly developed along that stream, are not the *Hudson river group*, but something else; and that the *Hudson river group*, if existing on the Hudson river at all,* is only represented there in the form of a few insignificant masses, so small that very few geologists have ever been so fortunate as to see them.

F. B. M. and A. H. W.

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* It is worthy of note that the few fossils mentioned to prove these little patches identical with the Cincinnati group—that is, *Leptæna sericea*, *Orthis testudinaria*, *Asaphus* and *Trinucleus*—are forms that also occur in the Trenton group, so that unless some decidedly characteristic species of the group under consideration, not yet mentioned, also occur there, we would, from the stratigraphical relations of these formations, have better reason to refer even these outliers to the Trenton period, than to a later formation. Even if they should, however, be found filled with the characteristic fossils of this western formation, their presence there, under such circumstances, would not warrant us in transferring to them the name Hudson river group, from the great series of older rocks to which it was originally applied.

NOTE.—In an introductory letter to the first volume, it was stated that an effort had been made by the enemies of the Survey to break it up, by repealing the law under which it was organized, and that it was only saved from destruction by the interposition of the *executive veto*. In making this statement, we inadvertently omitted to mention to whom the cause of science was indebted for this noble interference in her behalf; and it is but just to his Excellency, the Hon. Richard Yates, to say that it is to him that the Survey is indebted for its present existence, and for the opportunity to bring out for the information of the public so much of the results as are comprised in these two volumes. We feel assured that this noble act will be remembered and appreciated by the friends of science everywhere. A. H. W.

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PALÆONTOLOGY OF ILLINOIS.

SECTION I.

DESCRIPTIONS OF NEW SPECIES OF VERTEBRATES, MAINLY FROM THE SUB-CARBONIFEROUS LIMESTONE AND COAL MEASURES OF ILLINOIS.

By J. S. NEWBERRY and A. H. WORTHEN.

REMARKS

ON THE

OCCURRENCE OF FOSSIL FISHES IN THE ILLINOIS STRATA.

THE fossilized remains of fishes were observed in the Subcarboniferous limestone of Illinois, by one of the authors (A. H. W.), as early as 1845; and the fact that they were the only memorials of the vertebrated animals of the Carboniferous period then known in this country gave to this class of fossils a peculiar interest. As the fishes of this ancient epoch possessed a cartilaginous skeleton, they have left no record of their existence other than their teeth, the strong bony plates of enamel which lined their capacious jaws, and the bony defensive spines with which they were armed.

Although fragmentary in their character, these ichthyic remains presented such a variety of form and size as led to the conclusion that the number of species of vertebrated animals that existed, during the Carboniferous period, was by no means inconsiderable; and the bony structure of these fossils, and their deep brown or black color and shining surfaces, contrasting remarkably with the sober gray of the rough limestone in which they were imbedded, rendered them objects of striking interest to the collector of fossil remains.

In subsequent investigations it was discovered that there were certain horizons—usually limited to a single stratum, only a few inches in thickness—where these fossils were quite abundant, though comparatively rare in the intervening beds. Four of these "*fish beds*" have since been identified in the Sub-carboniferous limestone series in Illinois, and from these the new species now introduced to the notice of the scientific world were mainly obtained.

The Kinderhook group, consisting mainly of argillaceous and arenaceous beds, which form the base of the Carboniferous system in Illinois, has afforded but few of these ichthyic fossils, but on ascending to the Burlington limestone we find them more abundant; and in the upper part of this limestone occur the lowest beds that contain these remains, in any considerable numbers. In the upper part of this limestone we find a single stratum of brownish-gray rock, from four to six inches thick, in which the teeth and spines of fishes are imbedded in great numbers. This *fish bed* was first observed at Quincy, Illinois, and was subsequently identified, occupying apparently the same horizon, on Honey creek, in Henderson county, and at Augusta, in Iowa, points nearly a hundred miles away from the first named locality, showing that the cause which produced this general destruction among the vertebrated animals of this period was not local, but operated simultaneously over a wide geographical area. At Quincy there is a seam of green shaly clay, about two inches thick, interstratified with the limestone, beneath which, upon the surface of the underlying rock, the remains of fishes were found in considerable numbers, as though the animals had been destroyed suddenly by the introduction of this muddy sediment into the ocean. As this has not been observed at any other locality, it may, perhaps, be a merely local phenomenon.

The second *fish bed* is situated some fifty or sixty feet higher in the series, and is near the base of the quarry rock of the Keokuk group. It has only been identified at a single locality in the vicinity of Hamilton, in Hancock county. The rock is a single stratum of soft, granular, crinoidal limestone, and its friable character is probably in part due to surface exposure. It is about four inches thick, and crumbles readily under a smart blow of the hammer, so that the delicate fossils which it contains are often obtained entirely detached from the matrix. Although only about ten feet square of surface was exposed at this locality, it has afforded more than a thousand well preserved teeth. So thickly imbedded were they in this single layer, that a hand specimen of the rock, not exceeding four inches square, often exhibits a half dozen or more perfect teeth. The associated fossils are *Productus punctatus, Actinocrinus Nashvillœ, Zaphrentis Dalii and Sphenopoterium obtusum.*

The third *fish bed* in the ascending order is found in the upper part of the Keokuk limestone, just below the base of the geode bed. It was first observed in the vicinity of Warsaw, and subsequently identified at Nauvoo and some other localities in Hancock county. It is characterized by the remarkably large palate teeth of *Cochliodus nobilis* (N. and W.), and the large spine, *Drepanacanthus gemmatus.* Like the beds before described this consists of a single stratum of brownish-gray limestone, not exceeding four or five inches in thickness, and contains, besides the remains of fishes, *Spirifer neglectus, S. Keokuk, Productus punctatus* and *Zaphrentis Dalii.*

Ascending in the series to the horizon of the St. Louis limestone, the teeth of fishes become comparatively rare, and are only found as isolated specimens, sparingly dispersed through the rocky strata. The quarries in the vicinity of Alton and St. Louis, and near Waterloo, in Monroe county, have afforded a few fine species.

The Upper Archimedes or Chester limestone is more prolific in ichthyic fossils than the beds last named, and we again meet with strata in this group where they are crowded into a limited space in great numbers. The upper *fish bed* is found at the junction of the lower limestone in the Chester group, with the green shales above, and the stratum containing these fossils consists of thin plates of limestone imbedded in the shale. The rock is usually arenaceous and sometimes highly ferruginous, and in consequence of the hardness of the rock, well preserved specimens are more difficult to obtain from this bed than from those below. Very fine specimens are occasionally obtained from the soft shales in which the limestone are imbedded, and are found weathered out upon the sloping hill-sides below the outcrop of the bed in which they were originally inclosed.

In the Coal Measures the remains of fishes are comparatively rare in Illinois, and a single specimen will perhaps be the average reward of the collector for his day's labor in this horizon. The shales above the Belleville coal in St. Clair county, the argillaceous limestone and shale forming the roof of the coal seam near Springfield, and the State House quarries on Sugar creek, in Sangamon county, and an equivalent limestone at La Salle, have afforded nearly all the specimens yet found in the upper Carboniferous beds in Illinois.

The new species presented at this time comprise all that have been collected during the prosecution of the Geological Survey of the State up to 1862, as well as the private collection of one of the authors (A. H. W.), the result of more than ten years' labor, while a resident of Warsaw, in Hancock county, and in close proximity to some of the richest deposits of ichthyic fossils yet discovered on this continent. Although the new species now presented to the scientific world far exceed in number all that have hitherto been found in the paleozoic rocks of North America, we nevertheless believe that the localities mentioned are by no means exhausted, but will yet afford very many other new types.

The following query may have been suggested to the inquiring mind by the phenomena we have thus briefly attempted to describe: Why should the remains of fishes be found in such profusion, in the limited horizons which we have termed *fish beds*, while they are comparatively rare in the intervening strata? It seems to have been the probable result of one of two causes: either a superabundant development of ichthyic life during the accumulation of the sedimentary material that forms these thin beds of limestone, or else (and more probably) from the sudden introduction of heated waters or noxious gases, that caused a general and overwhelming destruction of the finny tribes of the Carboniferous ocean at these different periods. Such destructive agents may have been introduced, either by the action of submarine volcanoes or of thermal springs, and it is perhaps quite impossible, at the present time, to determine to which of these causes, if either, we are indebted for the phenomena we are now considering.

We know, from the recorded observations of the last century, that a submarine outburst of volcanic fire carries destruction to the finny tribes of the ocean as far as its influence extends, and we may readily conceive that the prevalence of thermal springs beneath the ocean's level, the waters of which were charged with mephitic gases, would produce a similar result. If we accept the commonly received opinion that the siliceous material which, in the form of chert and hornstone, enters so largely into the composition of the Burlington and Keokuk limestones, was introduced by thermal springs, we must conclude they were exceedingly numerous during the Sub-carboniferous period, inasmuch as we find these materials so abundant in some beds of the Sub-carboniferous limestone series as to constitute from one-fourth to one-half of the entire mass. Now, if we suppose these thermal waters to have been charged with any poisonous ingredient, we have an agent sufficiently potent to produce a very general destruction among the marine animals that were subjected to its influences.

With a profound conviction that the suggestions thus thrown out are not altogether a satisfactory answer to the query propounded, we have nevertheless felt impressed to offer them as the most probable solution presented by the facts before us, and with the hope that they may lead to further investigation and a more satisfactory answer to this interesting inquiry.

Of the 118 species of fishes described and illustrated at this time, 16 are from the Coal Measures, 17 from the Chester limestone, 18 from the St. Louis limestone, 49 from the Keokuk limestone, 14 from the Burlington limestone, 3 from the Kinderhook group, and 1 from Devonian strata.

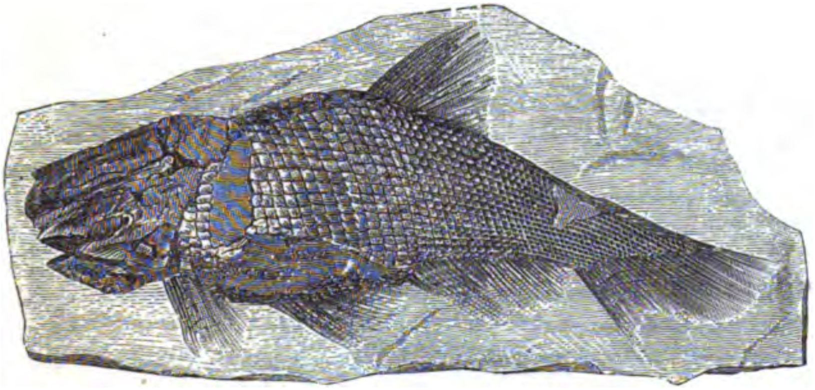
A. H. W.

GENUS PALÆONISCUS, DeBlainv.

PALÆONISCUS PELTIGERUS, Newb.

Elonichthys peltigerus, N. Proc. Phil. Acad. Sciences, April. 1856.

Fig. 1.



Palæoniscus peltigerus.

BODY short, compressed; length 5 inches; height 1 inch, 4 lines; enameled surface of cranial bones covered with small, thickly set tubercles; opercula and hyoid plates ornamented by parallel convolutions of thread lines; scales all covered with similar raised lines, which cross them diagonally downward and backward, terminating in serrations of the posterior margin. About the middle of the interval between the occiput and dorsal fin, on the median line, begins a row of large, oval, ornamented scales, extending to the dorsal fin. Behind the dorsal is a similar row, transformed into large striated fulcra, which overlie the prolongation of the vertebral column to its termination.

Fins large; dorsal triangular, about as high as broad at base, composed of about 26 rays; ventrals lower, but containing near the same number of rays; pectorals oblong, rounded at extremity, composed of about 10 rays; anal fin extending from ventrals to caudal, containing 40 or more rays; caudal as broad as anal, and apparently composed of an equal number of rays.

This pretty fish would seem to have been an inhabitant of many of the lagoons in the coal marshes, in different parts of what is now the valley of the Mississippi, as I have specimens of it from several localities in Ohio, Indiana and Illinois. It is probable, also, that it will prove to be one of the species which have been found in the rocks, associated with the "Albert" coal, in New Brunswick. I have some imperfect specimens from there of a species very closely allied to this, in which the only difference observable is the coarser and stronger ornamentation of the scales. All the species from the Albert mine, figured by Dr. JACKSON, are unmistakably *Palæonesci*, remarkable for the elaborate ornamentation of the head, bones and scales, and for the large dorsal scales, which, in common with the species before us, are borne by all of them. The finest specimens of *P. peltigerus* which I have are from beds of cannel coal in different localities, forming one of the many facts cited by the writer (Am. Jour. of Science, March, 1857) to sustain his conclusion that cannel coal was formed from a carbonaceous pulp, derived from thoroughly macerated vegetables suspended and deposited in water.

Formation and locality: Coal Measures, Fulton county, Illinois.

GENUS RHIZODUS, Owen.

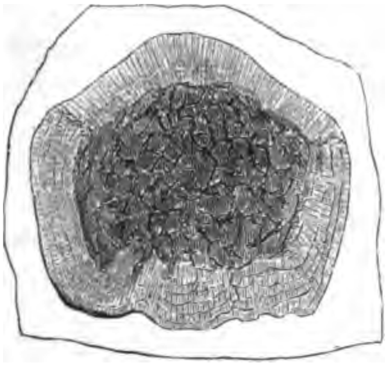
GEN. CHAR.—Jaws large, massive and bony, bearing several large, compressed, double-edged teeth, with sulcated bases in each dental bone, with numerous intermediate ones of similar form; scales large (1 to 5 inches in diameter), rotundate-quadrate in outline, thin, inner surface marked by concentric wavy lines of growth, and very finely reticulated; often marked with a tubercle of attachment; exposed portion of exterior surface covered with a fine vermicular tuberculation.

The considerations which actuated McCOY, in separating the large, thin, nearly plain scales, found in the Coal Measures, from the more massive and highly ornamented ones of the "Old Red," seems to be quite sufficient, though both had been long considered but species of the genus *Holoptychius*. The Devonian *Holoptychii* are well known by the discovery of numerous nearly entire individuals, in which scales, fins and bones are almost uninjured and unmoved; but the so-called *Holoptychii* of the Coal Measures are, as yet, only represented in collections by the large, thin scales which have been referred to, by numerous large, detached teeth, having fluted bases and a lenticular section, and by massive bony jaws, bearing these teeth and numerous intermediate and smaller ones.

In Ohio, what seem to be fragments of several species of *Rhizodus* have been discovered, by one of the authors, consisting of large, thin, quadrate, reticulated scales, numerous detached flattened teeth, and portions of jaws bearing teeth. In these jaws he observed that there are but a few of the large teeth with cutting edges, the spaces between them being occupied by much smaller teeth, having similar fluted bases, but with a circular section throughout.

RHIZODUS OCCIDENTALIS, N. and W.

Fig. 2.



Rhizodus occidentalis.

SCALES thin, rotundato-quadrate or sub-triangular in outline, 1¼ inches in diameter; anterior margin rounded; posterior scolloped; exterior surface unknown; interior marked with concentric wavy lines of growth, and, near the margin, very finely and beautifully striated.

This scale is the only representative, so far as our knowledge extends, of the genus *Rhizodus* yet found in the rocks of Illinois. As the scales and teeth of other species have been frequently met with in Ohio, it is probable that they will be hereafter found to occur in some localities in this State in considerable abundance. The scale before us is less quadrate in form than those of Ohio, and apparently represents a species up to the present time undescribed.

Formation and locality: In concretions of iron ore of the Coal Measures at Morris, Illinois.

GENUS CLADODUS, Ag.

GEN. CHAR.—"Teeth with broad, horizontal, semi-circular, thick, bony, coarsely-fibrous base, rounded behind, truncated in front; crown divided into long, sharp, subulate, conical points, arranged along the straight truncated edge of the base; medial cone much larger than the secondary ones, of which latter the external cones are largest; all the cones striated longitudinally, and either circular in section or with simple cutting edges, slightly compressed."

CLADODUS ROBUSTUS, N. and W.

Pl. 1, Figs. 1, 1 *a*.

TEETH small, robust, as high as broad; base trapezoidal, as long as median cone, moderately thick, arched before, widest behind, where it is somewhat rounder and emarginate, smooth throughout; median cone conical, recurved, equally arched before and behind with a lenticular section and cutting edges, smooth or finely and obscurely striated; lateral denticles rudimentary and tubercular, two on either side, exterior pair largest.

In its form, curvature and section the median cone of this species closely resembles that of *C. micropus*, but it is smooth or very faintly striated. The base is also larger and more angular, and the lateral denticles are less developed. It is quite possible that a larger amount of material would show that the two species shade into each other, and represent the dentition of different parts of the mouth in the fish; but until such connecting links are found, the differences which have been enumerated will serve to distinguish them.

Fig. 1 represents the anterior face; 1*a* the outline of the base, upper side, natural size.

Formation and locality: Keokuk limestone, Warsaw, Illinois.

CLADODUS MICROPUS, N. and W.

Pl. 1, Figs. 2, 2*a*, 2*b*.

TEETH of medium or small size, robust, higher than broad; base small, shorter laterally than height of median cone, elliptical, thick, rounded before and behind, and without anterior sinus; principal cone robust, conical, strongly curved inward; section lenticular throughout, with cutting edges; anterior and posterior surfaces both, though unequally rounded, finely and uniformly striated longitudinally; lateral cusps 1–2 on either side, very small, conical, acute, sometimes nearly obsolete.

The teeth of this species are exceedingly abundant in the "fish beds" of the Keokuk limestone in Illinois, and the collection contains a large number of them. They exhibit considerable diversity of form, but have as common characters their small elliptical bases, robust, recurved, ancipital, striated median cusps and dwarfed or tubercular lateral denticles. Many of the specimens are evidently beach-worn, and it is possible that their bases have been somewhat diminished, and the lateral denticles truncated by the attrition to which they have been subjected.

There are no described teeth with which these will be likely to be confounded, but they have much in common with two groups in the collection which have been referred to species designated by the names of *C. angulatus* and *C. robustus;* and though exhibiting marked differences, which are enumerated in the descriptions of the above species, it is quite possible that all formed portions of the dentition of a single species of fish. This is merely a conjecture, however, which can only be confirmed or disproved by the aid of more material than is now before us.

Fig. 2, anterior face; 2*a*, side view; 2*b*, outline of base from above.

Formation and locality: Keokuk limestone, Warsaw and Nauvoo, Illinois.

CLADODUS SPINOSUS, N. and W.

Pl. 1, Fig. 3, 3 *a*.

TEETH, of medium or large size, broader than high; base semi-elliptical, thick, smooth behind where it is brought to a sharpish edge, before strongly beveled under and scooped out in a shallow sinus beneath the median cone; whole anterior border of base, above the smooth beveled edge, set with innumerable minute spines directed upward; these spines cover the anterior bases of all the lateral denticles, and the base of the principal cone, with the exception of a small triangular space over the centre of the basal sinus, from which they diverge right and left, leaving the striation of the upper portion of the cone to run down nearly to the smooth surface of the beveled edge; median cone conical, somewhat curved backward, rapidly drawn down to an acute point; lower portion with a nearly circular section, finely and evenly striated longitudinally; near the point smooth, compressed, with cutting edges; lateral denticles 6–7, on either side, conical, striated and curved backward, exterior pair much larger than intermediate ones.

This beautiful species is readily distinguishable from all that have been described, by its spinous base. Fig. 3, anterior face and section of median cone, 3 *a*, portion of base, under side

Formation and locality: St. Louis limestone, St. Louis, Missouri.

CLADODUS MORTIFER, N. and W.

Pl. 1, Fig. 5.

Only a single tooth, and that much injured, represents this species in the collection; but that is so obviously distinct from all others, and the characters which it retains are so readily recognizable, that it may, perhaps, justly serve as a basis for a specific description. The summit of the principal cone is wanting, but enough of it remains to show that it was strongly compressed, with a lenticular section and cutting edges, was marked with fine, sharp striæ near the base, and smooth above. The lateral denticles are two in number on either side, relatively large, and differing but little in size. Like the median cone they are striated below, smooth, compressed and ancipital above. The outer pair must have been nearly half the length of the middle cone. The base of the tooth is of moderate thickness, in width about equal to twice the length of the larger lateral denticles.

In general aspect, the relative breadth and height, and the number and size of the lateral denticles, this species bears considerable resemblance to *C. mirabilis, Ag.* (*Pois. Foss., Vol.* 3, *p.* 197, *Atlas, Vol.* 3, *Tab.* 22 *b*, *fig.* 9–13), but that species is more generally and strongly striated, and the median cone has a circular section throughout.

Figure 5. Anterior face of broken tooth, with section of median cone.

Formation and locality: Coal Measures, Sugar creek, Sangamon county, Illinois.

CLADODUS STENOPUS, N. and W.

Pl. 1, Fig. 4, 4 *a*.

TEETH of medium size; breadth of base slightly greater than height; base laterally elongated and narrow, semi-elliptical, beveled to an edge behind, curved under before, where it has a broad but shallow sinus; median cone conical, with an expanded base, slightly curved backward, compressed, both anterior and posterior surfaces flattened, and very finely and uniformly striated; lateral denticles 6–7 on either side, exterior pair much the largest, intermediate ones, sub-equal.

There are no entire specimens of this species in the collection, the denticles being all more or less truncated. The narrow, smooth, broadly-sinused base, and the median cone, with both anterior and posterior surfaces flattened, and yet not acutely angled, except near the point, render it distinguishable at a glance, from the species associated with it. In size and surface markings it is not unlike *C. striatus Ag.* (*loc. cit. fig.* 14–17), but in that species this base is much thicker and broader, and the median cone is not compressed.

Figure 4, anterior face of mutilated tooth; 4 *a*, outline of base from above.

Formation and locality: St. Louis limestone, Warsaw, Illinois.

CLADODUS MAGNIFICUS, Tuomey.

Pl. 1, Fig. 6, 6 *a*.

C. magnificus: Tuomey, 2d report on Geology of Alabama.

IT is probable that this is the species to which Prof. TUOMEY gave the above name, though not quite certain, as he has left no description, and only an exceedingly rude wood cut to guide us.

The median cone, in the specimens before us, is very large and robust, nearly as high as the base is broad, somewhat compressed above and below, nearly cylindrical in the middle, without lateral angles, unless near the summit. It is strongly and evenly striated longitudinally. The base is very large and thick, truncated before, thinning out behind, rather smooth on both surfaces; lateral cones conical, smooth or finely striated, about 5 on either side, the exterior pair largest.

Figure 6, represents the anterior aspect, and 6 *a*, the outline of the base from above, natural size.

Formation and locality: Sub-carboniferous limestone, Huntsville, Alabama.

CLADODUS ANGULATUS, N. and W.

Pl. 1, Fig. 7, 8, 8 *a*.

TEETH of medium size, robust, width slightly less than height; base sub-elliptical, relatively thick; median cone conical, compressed, sigmoidally curved, medial portion of both anterior and posterior surfaces flattened, giving the section an angular outline; both surfaces finely striated longitudinally; lateral denticles one and sometimes two on either side, generally merely rudimentary.

Most of the specimens contained in the collection, which have been grouped together under the above name, exhibit, in the flattening of the central portion of the anterior and posterior surfaces, a strongly marked character by which they may be readily distinguished from any of the species now or heretofore described. There are other specimens, however, in which this character is not so distinctly visible, and which are not unlike *C. micropus* in the form of the median cone, but have a larger base. The teeth of *C. turritus* have also a similarly striated surface, and an approach to the angular outline of those under consideration, but in that species the lateral denticles are much larger, and the base is relatively thinner and smaller. For the present, therefore, it seems necessary to regard these teeth as specifically distinct from those with which we have compared them, but it is by no means certain, that by the discovery of new material, it will not be shown hereafter that the teeth now described under the names of *C. micropus*, *C. robustus*, *C. angulatus*, and *C. turritus*, form portions of the dentition of the same fish.

Figure 7, posterior face and section of median cone; 8 and 8 *a*, anterior face and base of another specimen.

Formation and loculity: Keokuk limestone, Hamilton and Warsaw, Illinois.

CLADODUS ZYGOPUS, N. and W.

Pl. 1, Fig. 9, 9 *a*, and 10.

TEETH small, as broad as high; base narrow, with a relatively deep sinus in front, which gives it somewhat the form of a yoke, and has suggested the name chosen; median cone conical, broad at base, rapidly narrowed to an acute summit, distinctly and evenly striated throughout, curved backward, anterior face flattened and deeply excavated below by the basal sinus; sides sharply angled below at the junction of anterior and posterior surfaces, ancipital towards the point, posterior face rounded; lateral denticles, two on each side, sub-equal; flattened before, rounded behind, striated, acute.

This highly ornamented and pretty species belongs to a group which includes *C. Hibberti*, Ag., *C. gracilis* and *C. costatus*, Nob. All of these are small in size, have two lateral denticles on either side; have a distinct sinus at the base of the median cone in front; have the median cone flattened in front, rounded posteriorly with cutting edges, and marked with distinct, sharp, longitudinal striæ. From each of its congeners *C. Zygopus* differs in several important characters. The basal sinus is deeper than in any other species known. The striation of the surface is finer and more crowded than in *C. gracilis* or *C. costatus*. The lateral denticles not as long and slender as in *C. gracilis*, nor as broad and flat as in *C. costatus*. In *C. Hibberti* the lateral cusps are much more unequal, the median cone less broad at base, and with a very shallow sinus.

Figures 9 and 9 *a*, anterior face and base of small specimen; 10, anterior face of a larger tooth; all natural size.

Formation and locality: Chester limestone, Chester, Illinois.

CLADODUS FEROX, N. and W.

Pl. I, Fig. 11 and 11 *a*.

TEETH of large size, breadth greater than height; base semi-elliptical, with a shallow sinus in front, smooth throughout; median cone slightly curved backward, conical, with a circular section, finely and evenly striated longitudinally; lateral denticles about 5 on either side; exterior pair one-third the height of the principal cone, conical, acute, striated throughout, divergent from median cone, and strongly curved backward; intermediate denticles about 4 on either side, largest, half the size of exterior pair, conical, striated, projecting forward.

The specimens of this species, contained in the collection, do not fully give the form of the principal cone, but it is apparently slender, conical, and acute. The lateral denticles are of the same character, but curved backward at very different angles; the posterior pair being set on the same line with the median cone, and hooked backward much more than that, while the intermediate cones are set in advance of these, and less curved. Bristling, as these teeth did, with a multitude of sharp, fang-like denticles, pointing in different directions, they must have been among the most effective of all the varied forms of dental armament possessed by plagiostomous fishes. There is no described species with which this is liable to be confounded. The form of the principal cone was similar to that of *C. striatus*, Ag., (*Pois. Foss. Vol.* 3, *p.* 197, *Atlas*, *Vol.* 3, *tab.* 22 *b*, *figs.* 14–17), but the striation of the surface was finer, and the number and form of the lateral denticles quite different.

Among those associated with it in the collection, perhaps *Cladodus spinosus*, Nob., approaches it nearest, but while the median cone of that species is alike conical and similarly striated, the lateral denticles are more numerous, and the thicker base, with its beveled anterior margin, roughened with a thousand minute spines, furnishes a character which will serve to distinguish it at a glance.

Figure 11, anterior face of broken tooth, with section of median cone; 11 *a*, base underside, natural size.

Formation and locality: St. Louis limestone, St. Louis, Missouri.

CLADODUS POLITUS, N. and W.

Pl. I, Fig. 12.

TEETH small, as high as broad; base flat below, nearly straight before, terminating in a somewhat acute edge posteriorly, and on either side; median cone conical, very acute, slightly compressed, without cutting edges, smooth and polished throughout; lateral denticles one on either side, with an inner rudimentary one, scarcely more than a tubucle.

The anterior face of *C. lamnoides* is nearly as smooth and highly polished, and, when not fully exposed, these species might be mistaken for each other; but in *C. politus* the lateral cusps are not set on the edge of the base, are divergent, and a rudimentary denticle is usually visible between the exterior one and the central cone.

There is in the collection another perfectly smooth tooth which is scarcely distinguishable from the specimens of *C. politus*, except that it has cutting edges. It may be merely a variety, and at least is too near like it to justify us in making a distinct species out of it without more material. That tooth was obtained at Honey creek, in Henderson county, from a different geological horizon, and very possibly will prove distinct.

Figure 12, anterior aspect, natural size.

Formation and locality: Chester limestone, Chester, Illinois.

CLADODUS COSTATUS, N. and W.

Pl. I, Figs. 13, 13 *a*.

TEETH small; base flat, thin, anterior border straight, or slightly convex, beveled upward and backward to the bases of the denticles; principal cone conical in outline, compressed, ancipital, anterior surface marked with about 6 (3 on either side of the centre) smooth, longitudinal costæ, or sharp, coarse, prominent striæ, which converge at the base of the cone; lateral denticles two on either side, conical, compressed, and marked like the middle cusp, with a few prominent longitudinal carinæ.

This is a remarkably neat little species, clearly distinct from any with which it is associated, or that have been heretofore described. It is related, however, to *C. Hibberti*, Ag., from the limestone of Burdie House, but in that species the lateral cusps are much more unequal in size, and, like the principal cone, are finely and evenly striated from base to summit.

There is another small, compressed, sparsely striated species in the collection, from the Coal Measures of Indiana (*C. gracilis*, Nob.), but in that the central cusp, though compressed, is narrower, and the lateral ones are long, curved and cylindrical.

Figure 13, 13 *a*, anterior face and base, natural size.

Formation and location: Chester limestone, Chester, Illinois.

CLADODUS TURRITUS, N. and W.

Pl. 1, Fig. 14.

TEETH of medium size, higher than long; base thin, flat, shorter, laterally, than the height of the median cone, subelliptical in outline, wider behind than before; median cone conical, covering more than half the base, sigmoidally curved, the point turned forward, compressed, with cutting edges, anterior and posterior faces unequally arched, and often flattened along the median line, producing an angular section, both faces finely striated, striation of posterior surface strongest; lateral denticles one on either side, with a rudimentary tubucle between it and the principal cone, nearly vertical, compressed, acute, striated, and curved in the same way as the median cone.

The typical form of this species, represented by Fig. 14, in the narrow, conical and rigid outline of the central and lateral cusps, resembles a miniature spire with two flanking pinnacles, a resemblance which has suggested the name given it. The relative length of the base is less than in any other described species, unless in *C. micropus*, which, though smaller, more curved, and with less developed lateral denticles, is otherwise not unlike it.

Figure 14, anterior face and section of median cone, natural size.

Formation and locality: Keokuk limestone, Warsaw and Nauvoo, Illinois.

CLADODUS GRANDIS, N. and W.

Pl. 1, Figs. 15, 15*a*.

TEETH very large and robust; breadth 1½ times the height; base thick and flat, anterior border excavated by a broad sinus beneath the median cone, and marked with numerous fine, sharp, vertical carinæ anterior to the bases of the lateral denticles; median cone robust, acute, somewhat flattened throughout, especially on the anterior face, upper two-thirds with a lenticular section and cutting edges, basal half of anterior surface finely longitudinally striated, upper half smooth, two-thirds of posterior surface marked with stronger vertical striæ, which converge to the base of the dorsum; summit smooth; lateral denticles numerous (5–8 on either side) and very unequal in size; exterior pair one-fourth the length of the principal cone, conical and strongly striated at base, compressed and smooth at summit; intermediate ones sub-equal, very small, striated.

This is the largest tooth of the genus yet discovered, and must have formed the armament of a fish of formidable dimensions and prowess. In one specimen the principal cone, now somewhat mutilated, must have been 1½ inches in length; in another, nearly entire, the median cone is 1 inch, 1 line in length; the base 1 inch, 8 lines broad.

From all species hithereto discovered this is readily distinguishable. Approaching, by its general aspect and fine striation, most nearly to *C. Milleri*, Ag., it is widely separated from that species by the compressed form and trenchant edges of the median cone and the greater number and marked inequality of the lateral denticles. Of the species with which it is associated in the collection, *C. magnificus*, Tuomey, (if we have correctly identified that species), is most like it in general aspect and nearly equals it in size; but in *C. magnificus* the principal cone is much less compressed, is more strongly and generally striated and the striæ are of very different character. In *C. grandis* they are fine, acute and often broken and forked, while in *C. magnificus* they are stronger, flattened, nearly continuous and parallel. The lateral denticles, too, in *C. magnificus* are nearly smooth, while in *C. grandis* they are rendered angular by the strong though few striæ, which they bear.

Fig. 15 represents the anterior face of a nearly perfect tooth; 15*a*, a perfect base of a smaller specimen—both of the natural size.

Formation and locality: Chester limestone, Chester, Illinois.

CLADODUS LAMNOIDES, N. and W.

Pl. I, Figs. 16, 16*a*.

TEETH small, height exceeding length of base; base narrow, straight before, arched behind, relatively thin, smooth; median cone narrow, conical, recurved or often doubly curved, slightly rounded before, strongly so behind, very acute at point, with cutting edges which extend to near the base; anterior surface smooth; posterior face finely striated longitudinally, except near the point, which is smooth; lateral denticles two, one-fourth the length of the principal cone, sub-cylindrical, acute.

This is a remarkably neat and graceful species; in form not unlike the teeth of some of the living species of *Lamna*. When showing only the anterior surface of the tooth, it might be mistaken for *C. politus;* but in that species the base is broader, the lateral denticles are double on either side, and are not set on the margin of the base.

Fig. 16 represents the posterior surface, with a section of the median cone; Fig. 16*a* is a side view of same tooth—both natural size.

Formation and locality: Keokuk limestone, Warsaw and Nauvoo, Illinois.

CLADODUS GRACILIS, N. and W.

Pl. I, Fig. 17.

TEETH small, delicate and slender in all parts, height about equal to breadth; median cone narrowly conical in outline, acute, compressed, with sharp lateral edges, anterior surface flattened, middle and basal portions marked with a few coarse, somewhat irregular, sharply prominent striæ, summit smooth; lateral denticles two on each side, long, slender, nearly cylindrical, coarsely striated, and, like the median cone, slightly curved backward.

It is to be regretted that this very peculiar species is not represented in the collection by more than a single specimen, as it presents some singular anomalies of form. The median cone is much compressed, with cutting edges from summit to base, while the lateral cusps are relatively very long, nearly equal in size, and with a circular outline. They are not unlike *C. costatus* in the form of the central cusps, yet the striation is more irregular. The lateral denticles are much longer and more slender and widely different, in their section.

Fig. 17, anterior face and section of median cone; natural size.

Formation and locality: Coal Measures, Posey county, Indiana.

SYNOPSIS OF PETALODONT GENERA.

Family PETALODONTIDÆ, N. and W.

TEETH compressed, transversely elongated, crown with anterior and posterior surfaces enameled, meeting above in a more or less acute-angled edge, bordered below by imbricating folds of enamel, which encircle the crown; anterior crown-face generally convex; posterior, concave; root more or less developed, sometimes large, sometimes nearly obsolete, bony, rough, tumid.

1. GENUS PETALODUS, Owen.

"TEETH transversely elongated, much compressed, thin, petal-shaped, cutting edge serrated; base of crown, with several narrow imbricating folds of enamel, descending lower on the posterior than anterior face; root large, oblong, thin, truncated below; lower edge obtuse, tumid."

The difficulties which stand in the way of any attempt to establish generic and specific distinctions, among extinct plagiostomous fishes, from the teeth as they are usually found, detached from their connections and scattered through the rock containing them, are strikingly illustrated by the group of *Petalodoid* teeth before us.

This collection embraces nearly one hundred specimens, in various states of preservation—many of them beautifully perfect—which exhibit modifications of a common type of form, and, so far as they have been been examined microscopically, a common structure; and yet it is quite impossible to bring them all within the limits of any one of the allied genera established by Owen, Agassiz or McCoy. Selections may be made from them distinctly representing *Petalodus*, *Polyrhizodus*, *Chomatodus*, etc.; but with these are intermediate forms, which serve as connected links between the others, and make it difficult, if not impossible, to break the series up into satisfactory and well defined generic groups. Doubtless if we could have for study the entire organism now so dimly shadowed forth in these numerous, variable and disconnected teeth, we should find in the form, in the complete dentition or in other organs—the fins, the spines, the bronchial openings, etc.—characters by which the group of fishes here represented might be arranged in a large number of well defined genera, the community of form and structure which their teeth exhibit would probably then be shown to be a family, and not a generic character.

P. Hastingsi, Owen (type). Sub-carboniferous, Europe.
P. acuminatus, Ag. Sub-carboniferous, Europe.
P. destructor, N. and W. Coal Measures, Illinois.
P. linguifer, N. and W. Sub-carboniferous, Illinois.
P. alleghaniensis, Leidy. Coal Measures, Penn. and Ohio.

2. GENUS PETALORYNCHUS, Ag.

TEETH small; crown compressed, thin, concavo-convex petal shaped, relatively higher and narrower than in *Petalodus;* imbricating folds on posterior face forming a short, transverse band, *not extending to the lateral angles of the crown;* root long, undivided.

S. sagittatus, Ag.—name only—(type). Sub-carb., Europe.
P. psittacinus, Ag.—name only. Sub-carboniferous, Europe.
P. striatus, N. and W. Sub-carboniferous, Illinois.

3. Genus CTENOPTYCHIUS, Ag.

Teeth small; crown as in *Petalodus, but upper margin serrate, crenulate or dentate;* root oblong, rounded, entire.

Ct. seriatus, Owen (type). Sub-carboniferous, Europe.
Ct. apicalus, Ag. Sub-carboniferous, Europe.
Ct. semicircularis, N. and W. Coal Measures, Indiana.

4. Genus ANTLIODUS, N. and W.

Teeth transversely elliptical, compressed, concavo-convex; crown similar to that of *Petalodus; root short or obsolete.*

A. mucronatus, N. and W. Sub-carboniferous, Illinois.
A. parvulus, N. and W. Sub-carboniferous, Illinois.
A. similis, N. and W. Sub-carboniferous, Illinois.
A. cucullus, N. and W. Sub-carboniferous, Illinois.
A. politus, N. and W. Sub-carboniferous, Illinois.
A. minutus, N. and W. Sub-carboniferous, Illinois.
A. simplex, N. and W. Sub-carboniferous, Illinois.
A. sulcatus, N. and W. Sub-carboniferous, Illinois.
A. robustus, N. and W. Sub-carboniferous, Illinois.

Probably *Chomatodus truncatus*, Ag., (*McCoy Brit. Palæoz. Foss., p.* 618, *pl.* 3*c*, *fig.* 1) and *Chom. linearis*, Ag., the specimen figured Poiss. Foss. Atlas, pl. 12, fig. 5, should be included in this genus.

5. Genus DACTYLODUS, N. and W.

Crown as in *Petalodus;* root conspicuous and *divided into a number of radicles.*

D. princeps, N. and W., (type). Sub-carboniferous, Illinois.
D. lobatus, N. and W. Sub-carboniferous, Illinois.
D. inflexus, N. and W. Sub-carboniferous, Illinois.

D. digitatus, N. and W. Sub-carboniferous, Illinois.
(*Ctenoptychius digitatus*, Leidy.)

6. Genus POLYRHIZODUS, McCoy.

Crown having general structure of *Petalodus*, but much more elongated, transversely lower, and relatively thicker, as in *Chomatodus; root divided into numerous short, robust radicles.*

P. magnus, McCoy, (type). Sub-carboniferous, Gt. Britain.
P. porosus, N. and W. Sub-carboniferous, Illinois.
P. dentatus, N. and W. Sub-carboniferous, Illinois.
P. ponticulus, N. and W. Sub-carboniferous, Illinois.
(*P. pusillus*, McCoy, is a *Helodus*.)

7. Genus CHOMATODUS, Ag.

Teeth transversely much elongated, compressed and depressed, crown having the homologous parts of *Petalodus* and the form and structure of *Polyrhizodus; root short, sometimes obsolete, undivided.*

Ch. linearis, Ag. (type). Sub-carboniferous, Europe.
Ch. gracillimus, N. and W. Sub-carboniferous, Illinois.
Ch. cultellus, N. and W. Sub-carboniferous, Illinois.
Ch. loriformus, N. and W. Sub-carboniferous, Illinois.
Ch. molaris, N. and W. Sub-carboniferous, Illinois.
Ch. pusillus, N. and W. Sub-carboniferous, Illinois.
Ch. affinis, N. and W. Sub-carboniferous, Illinois.
Ch. angularis, N. and W. Sub-carboniferous, Illinois.
Ch. multiplicatus, N. and W. Sub-carboniferous, Illinois.
Ch. elegans, N. and W. Sub-carboniferous, Illinois.
Ch. venustus, Leidy. Sub-carboniferous, Illinois.

GENUS PETALODUS, Owen.

PETALODUS DESTRUCTOR, N. and W.

Pl. II, Figs. 1 and 3.

TEETH large; crown sharped, compressed, more or less arched laterally, rhomboidal in form, with curved outlines, somewhat acumenate at apex; cutting edge very sharp, crenate; anterior face smooth and polished, broadly rhomboidal, lateral angles very acute, upper one slightly rounded, lower one broadly so; posterior surface one-third to one-half higher than anterior face, smooth and polished, terminating below, like the anterior surface, in a band of 5–6 imbricated folds, which are broader and more strongly marked behind than before; root nearly smooth, broad, and compressed above, narrowed and thickened below, where it is rounded, and deflected forward; posterior face about the height of the posterior face of curve; anterior face one-third higher.

Entire length of a large specimen, 2 inches, 3 lines; height of posterior surface of crown, including basal folds, 1 inch, 3 lines; of anterior surface, 9 lines; breadth, 1 inch, 9 lines; length of root, anterior surface, 1 inch, 6 lines; of posterior face, 1 inch.

These large and fine teeth, as will be seen by reference to the figures given, must have formed the dental armament of one of the most formidable of the Carboniferous Placoids, and the equal in size and prowess to the gigantic Sauroids of that age.

In some specimens, included in the collection, the crown is an inch in height by one and a half inches in breadth—equaling in size the teeth of the largest living species of *Carcharias*, while the root, comprising half the tooth, buried in the integuments, must have given to the trenchant crown a firmness and efficiency far greater than that of any of the modern shark's teeth, which have only a short tuberous base.

Some of the specimens show much wear, but still retain the sharpness of cutting edges. This would seem to show that the teeth of the opposite jaws shut together like a pair of shears, and the attrition which they suffered served only to keep them in order.

The general form of the crown varies much in some instances; as in that represented in Fig. 3, it is only half the usual height. In other respects, no difference is discernable between that and the others; and there is scarcely room for a doubt that both forms belonged to the same species, possibly to the same individual, the difference being due to the place held by the different teeth in the series, with which each jaw was furnished.

The striation of the edge is usually very distinct and regular. It is produced by the exposure of the calciguous tubes of the enamel, which are arranged in a series directed toward the edge, and are here much larger than elsewhere. In unworn teeth the striæ are very short, the tubes of the anterior and posterior surfaces being exactly opposite; their points of junction forming depressions on the edge. The crenulation thus produced, is, in young teeth, beautifully regular; in older and worn ones it becomes irregular and at length obsolete. When the polished enamel coating of the anterior and posterior faces is worn off, a dotted surface is exposed similar to that of *Psammodus*. This appearance is due to the cutting across of the calciguous tubes, which appear to be set here at right angles to the surfaces. These dots are particularly noticeable on the basal folds in worn specimens.

The interior of the tooth is quite dense and hard, but exhibits an irregular cellular structure. The root is more spongy, and in some cases seems to have been imperfectly ossified.

The described species of *Petalodus*, to which this is most like, are *P. acuminatus*, Ag., (*Poiss. Foss. Vol.* 3, *pp.* 108, 174, *T.* 19, *f.* 11–13), (*McCoy*, *Brit. Palæozoic*, *Foss. p.* 635, *Pl.* 3 *g*, *Fig.* 4), and *P. Alleghaniensis*, Leidy. (*Jour. Acad. Nat. Sci. Phila.*, 2*d series. Vol.* 3, *p.* 161, *Pl.* 16, *f.* 4, 5 *and* 6.) The one from the Carboniferous limestone of England, and the other from the Coal Measures of Pennsylvania. From the first it differs in the greater relative height of the crown, and the longer and narrower root. From the second it is possibly not specifically distinct, as we only know that through the single specimen figured and described by Dr. LEIDY. If that specimen is a fair representation of *P. Alleghaniensis*, our species may be distinguished from it by its crown, which is more pointed above, and much less arched laterally; and by the root, which is longer and narrower. It should be said, however, that we have every reason to believe that the teeth of *Petalodus*, from the different portions of the mouth, are considerably different in form, and it is not at all unlikely that the discrepancies between Dr. LIEDY'S specimens and ours will prove to be insufficient grounds on which to establish a specific distinction.

Figures 1, 1 *a*, and 2, 2 *a*, represent anterior and posterior views of the crowns of two mature teeth; 2 *b*, the root anterior surface; 2*c*, profile section; Fig. 3, a small and low crown anterior face, all natural size.

Formation and locality: Coal Measure limestones of Springfield, LaSalle and Sugar creek, Illinois.

PETALODUS LINGUIFER, N. and W.

Pl. II, Figs. 4, 4 *a*, 4 *b*, 5, 5 *a*, 5 *b*, 5 *c*.

TEETH large, broader than high; crown three times as broad as high, straight or very slightly arched laterally, cutting edge broadly and nearly evenly arched, apiculate at the summit, strongly striated before, less so behind, finely crenulated; anterior surface very broadly rhomboidal, highly polished; basal imbricated folds narrow; posterior face slightly higher than anterior, like that broad, rhomboidal in outline, smooth and highly polished, much arched vertically, very slightly so laterally, bordered below by a broad band of 7–8 imbricating folds of enamel; root smooth except where peirced by the nutrient vessels, accurately tongue-shaped, rounded below, posterior face equal in height to the posterior face of the crown, including basal folds; anterior face one-third the higher. Total height of tooth, 12 lines; breadth, 18 lines.

In the form of the crown, these teeth bear considerable resemblance to those of *P. acuminatus*, Ag., but differ in having the upper lines of their rhombic outline convex instead of concave; the root, too, is less wide. In *P. acuminatus*—as would appear from the figures of Agassiz and McCoy—it is as broad where it unites with the crown, as the crown itself; while in *P. linguifer* it is much narrower, and is precisely of the form of the terminal half of the human tongue. In the very beautiful and perfect specimen from Pope county, (Fig. 4), the tongue-like root is broader than in those from Chester, (Figs. 5, 5*c*), but is still much narrower than in the described specimens of *P. acuminatus*.

It is, perhaps, possible that the Chester specimen should constitute a distinct species, but with the exception of the difference in the form of the root, they seem to be alike.

It will be seen from the sections given (Figs. 5 *b*, 5 *c*) of two specimens from the Chester limestone, that they show a marked difference in the relative height of the crown, but this is a character which is particularly inconstant in all the species of *Petalodus*.

Figures 4 and 4 *a*, a perfect specimen from Pope county, seen from behind and above; 4 *b*, section of same; 5, 5 *a* and 5 *b*, anterior and posterior faces, and section of a worn specimen from Chester; 5 *c*, profile section of another Chester specimen.

Formation and locality: Chester limestone, Chester and Pope county, Illinois.

GENUS ANTLIODUS, N. and W.

ANTLIODUS MUCRONATUS, N. and W.

Pl. II, Figs. 6, 6 *a*, 6*b*.

TEETH small, robust, broader than high, posterior crown face lenticular in outline, with very sharp angles, concave vertically and laterally, smooth or very finely striated vertically under the lens; superior border regularly arched, finely crenulated; basal folds about 5, upper one nearly equaling the lower four in breadth, forming a narrow, prominent, bow-shaped ridge; anterior surface equal in height to posterior, strongly arched laterally, vertically concave below, arched above; basal ridge a sharp prominent angle, without distinct folds; base arched laterally, strongly concave vertically, smooth; root two-thirds as wide as the crown, apparently divided into several radicles.

A very distinct and neat species, characterized by its low, thick, and strongly arched crown, terminating laterally in very acute depressed points.

Figures 6, 6 *a*, 6 *b*, represent front and rear views, with profile, natural size.

Formation and locality: St. Louis limestone, Alton, Illinois.

ANTLIODUS PARVULUS, N. and W.

Pl. II, Figs. 7, 7 *a*.

TEETH small, elliptical in outline, height two-thirds the breadth; cutting edge regularly arched, crenulated; anterior surface of crown just half the height of the tooth exclusive of the rudimentary root, smooth and polished, except along the upper border, where it is striated, terminating below in a bow shaped coronal ridge; posterior surface concave, higher than anterior, smooth with the exception of the striæ along the cutting edge; root nearly obsolete, existing only as a narrow fringe below the central two-thirds of the crown. Height 4 lines; breadth 6 lines.

This elegant little species resembles, in size and outline, *A. minutus*, but is readily distinguishable from it by its discernible, though small, root, and the greater relative height of the anterior face of the crown—differences distinctly shown in the profiles of the two species.

Figures 7 and 7 *a*, represent, respectively, the anterior and posterior faces, and the profile, natural size.

Formation and locality: Burlington limestone, Quincy, Illinois.

ANTLIODUS ROBUSTUS, N. and W.

Plate II, Figs. 9, 9*a*, 9*b*, 9*c*.

TEETH of medium size, thick and massive, much broader than high; crown twice as broad as high, upper margin regularly arched, somewhat rounded, obtuse and porous; anterior surface semi-elliptical, half the height of tooth, regularly arched vertically and laterally, smooth and polished, in its normal state, except along the upper margin, where it is striated by the exposed enamel tubes; below these tubes inosculate, producing a reticulated, still lower a dotted porosity; anterior coronal ridge narrow, bow-shaped, prominent, and showing several folds of enamel; posterior surface smooth, regularly concave in both directions, one-third higher than anterior face, exclusive of the broad coronal ridge, which is arched downward or slightly bow-shaped, showing 5–6 distinct imbricating folds, of which the upper one is much the broadest; base nearly smooth; root two-thirds the entire breadth of the tooth, very short, slightly projecting below the posterior coronal ridge, tubercled or roughened, not divided.

This, and the other species of the short-rooted group of *Petalodonts*, to which it belongs, exhibit the singular feature of a crown which is essentially that of the typical species of *Petalodus*, but having the root, so conspicuous in those species, dwarfed to a mere tuberculated ridge, set on the base, as in the present species, *A. parvulus*, *A. cucullus*, etc.—or still more rudimentary or wholly wanting, as in *A. simplex* and *A. minutus*.

That this departure from the normal type, in the form of the teeth, was associated with various other modifications of the structure of the fishes to which they belong, by which their whole economy was changed, there can be no doubt. We have, therefore, felt justified in placing them in a generic group by themselves.

Figs. 9, 9*a*, 9*b* and 9*c* represent the anterior and posterior surface, side view and profile of a large specimen from the Chester limestone.

Formation and locality: Chester limestone, Chester, Illinois.

GENUS PETALORHYNCHUS, Ag.

PETALORHYNCHUS STRIATUS, N. and W.

Pl. II, Figs. 8, 8 *a*, 8 *b*.

TEETH small and thin; crown sub-pentagonal in outline, flat or slightly arched laterally, summit sloping either way to two lateral angles where the tooth is broadest, thence the sides converge to the basal folds; cutting edge sharp, finely and rather irregularly crenulate; anterior surface slightly less high than the posterior, central portion raised into a broadly rounded vertical ridge, bordered by parallel shallow depressions, upper two-thirds uniformly marked by fine vertical or divergent striæ, showing the courses of the calcigerous tubes, which are somewhat branched; basal folds few, (2–3), strong mesial angle turned up instead of down; posterior surface plane, slightly curved backward at the base, smooth below, striated above; imbricated folds at base 2–3, broad, nearly straight, and horizontal; root unknown.

This unique and pretty species bears a distinct resemblance to *P. sagittatus*, Ag. (*McCoy Brit. Palaeoz. Foss. p.* 636, *Pl.* 3 *i*, *fig.* 2, 3), but may be readily distinguished from it by its thin, flat crown, so distinctly and peculiarly striated; the reversed basal angle of the anterior surface, etc.

Figures 8, 8 *a*, 8 *b*, are views of the front and rear faces of the crown, and section, all natural size.

Formation and locality: Burlington limestone, Quincy, Illinois.

ANTLIODUS SIMILIS, N. and W.

Pl. II, Figs. 10, 10*a*.

TEETH rather small, thick and strong; crown twice as broad as high, upper margin regularly arched, obtuse or sub-acute; anterior surface semi-elliptical, not quite half the height of the tooth, arched both vertically and laterally, smooth and polished except where worn; upper margin striated, lower slightly bow-shaped; posterior surface rather more than twice the height of the anterior, curved in both directions; lower margin marked with fine, imbricating folds, and forming a thin, prominent edge; root short, thick.

This species approaches very nearly, in form, to *A. robustus*, but is smaller, and the angle formed at the edge of the crown, by the anterior and posterior surfaces, is larger, giving to the tooth, as it stands vertically, a somewhat flatter top. This difference is most clearly seen in the profile sections of the two species. The root also projects more anteriorly. So like, however, are the two species, that if they had been found at the same geological horizon, they would with propriety have been considered mere variations in form, of one and the same species.

Figs. 10 and 10*a* represent the anterior face and profile section of the natural size.

Formation and locality: Keokuk limestone, Warsaw, Illinois.

ANTLIODUS CUCULLUS, N. and W.

Pl. III, Figs. 1, 1*a*, 1*b*.

TEETH of rather large size, robust, elliptical in outline, much broader than high, superior border regularly arched, thickened, rounded, striated and obtuse; posterior face of crown sub-elliptical, smooth, terminated below by a broad, flattened coronal ridge, which is arched downward and marked indistinctly with imbricating folds; anterior face of crown lenticular in outline, half the height of posterior face, regularly arched laterally, terminating in long, acute points, slightly concave vertically, bounded by prominent ridges, one formed by a thickening of the superior border, the other the basal ridge. The latter is slightly bow-shaped and faintly marked with parallel folds; base very smooth, slightly arched laterally; root three-fourths the breadth of crown, very short, scarcely reaching the lower border of the posterior coronal ridge, rough and irregular, somewhat divided into rudimentary radicles.

This species resembles, in its general aspects, *A. robustus*, but is readily distinguishable from it by its thickened edge, its concave anterior face, broader base, shorter root, etc. Its profile, nearly that of the ladies' bonnets now in fashion (1860), has suggested the name given it.

Figs. 1, 1*a*, 1*b* represent both faces and profile, natural size.

Formation and locality: Keokuk limestone, Nauvoo, Illinois.

ANTLIODUS POLITUS, N. and W.

Pl. III, Figs. 2, 2*a*.

TEETH small, thick, exceedingly hard and dense, elliptical in form; superior border of crown regularly arched, truncated and slightly furrowed; posterior surface smooth and polished, elliptical in outline, concave vertically, straight laterally; coronal folds numerous, broad, flat, evenly arched downward; anterior surface lenticular, long-pointed laterally, one-half the height of the posterior surface, straight or slightly curved vertically, arched laterally; anterior coronal ridge sub-acute, narrow, prominent, and marked with several fine, parallel, enamel folds; base sub-elliptical in outline, smooth; root rudimentary, forming a prominent tuberculated ridge as long as half the breadth of the tooth, set in the base near its lower border; under the lens the structure appears very dense and close throughout, a few pores opening along the borders of the superior marginal sulcus.

This, and the closely allied *A. sulcatus*, are among the most interesting species represented in the collection. Their relations to some of the nearly rootless forms which we have described, such as *A. cucullus*, etc., are close, as is evinced by their general resemblance of form and the perfect correspondence in all their homologous parts; but in *A. politus* the thickened edge of those species with which we have compared it is truncated and even sulcated, the margins of the sulcus being composed of denser tissue and wearing less rapidly. The office of the tooth was plainly that of a grinder, the triturating surface being fitted for its duty as in the ruminants, rodents, pachyderms, etc., by the alternation of harder with softer bands of dental tissue.

The entire tooth is excessively hard and dense, showing an interesting adaptation to the purposes it was intended to subserve.

Figs. 2, 2*a* represent the posterior aspect and profile of an average sized tooth, natural size.

Formation and locality: Keokuk limestone, Warsaw and Nauvoo, Illinois.

ANTLIODUS MINUTUS, N. and W.

Pl. III, Figs. 3, 3*a*, 3*b*.

TEETH very small and thin; root rudimentary or obsolete; crown elliptical in outline, cutting edge uniformly arched and finely crenulated; posterior surface occupying half the height of the tooth, concave vertically and horizontally, smooth and polished throughout except along the superior margin, where it is striated to the cutting edge; posterior basilar imbricated folds 4–5, distinctly marked and occupying the lower half of the posterior surface; anterior face of crown very narrow, forming scarcely more than one-fourth of the antero-inferior surface, inclined to the inferior surface at an angle little greater than a right angle, smooth and polished, terminating below in a single prominent basal ridge, which is arched parallel with the cutting edge; inferior surface of the tooth roughened for its attachment to the integuments, and showing, in a few low tubercles, the rudiments of the root; length 6 lines; height 3 lines.

This beautiful little tooth is remarkable for the entire absence of a root. It seems to have been attached to the jaw by a roughened surface, occupying the interval between the anterior and posterior coronal folds, which are very widely separated. The character would exclude the species from the genus *Petalodus*, as defined by Owen; but with that exception there could scarcely be a more perfect type.

Of the figures given, figure 3 represents the posterior surface, natural size; 3*a* the same, enlarged to two diameters; 3*b* profile or section through the center of tooth, also twice the size of nature.

Formation and locality: Keokuk limestone, Warsaw, Illinois.

ANTLIODUS SIMPLEX, N. and W.

Pl. III, Figs. 4, 4*a*.

TEETH small, long-elliptical in outline, superior border arched, acute, striated on the anterior side, dotted posteriorly; posterior face, long-elliptical, smooth and porous throughout, slightly arched virtically, laterally straight, bordered below by a narrow and low coronal ridge; anterior surface half the height of posterior, nearly straight vertically, and in the central portion laterally, toward either side regularly arched, upper two-thirds finely striated vertically; anterior basal ridge low, simple, nearly straight; base occupying half the anterior aspect of the tooth, slightly arched both ways, inclined at right angles with the anterior face of crown, roughened in the place occupied by the root in the species; root, none.

The only specimen of this species in the collection is somewhat worn, but is sufficient to indicate its entire distinctness from all others described. The posterior face has been exposed to long wear, when on the jaw, and the normal character of this surface can hardly be deduced from it. It is now regularly dotted all over with the ends of the enamel tubes, precisely as in *Psammodus*. As has been mentioned, all the *Petalodonts*, when much worn, present something of this appearance. In this species it is more marked, however, than in any other, and evidently depends on a peculiarity in the microscopic structure of the crown. The cutting edge is quite thin, and the porosity of its posterior surface is occasioned by the uniform direction of the enamel tubes. These are set parallel with the slope of the anterior face, marking that face with vertical striæ, but dotting the posterior face with their ends cut obliquely.

Fig. 4 represents an anterior view of tooth; Fig. 4*a*, a profile section—both natural size.

Formation and locality: Burlington limestone, Burlington, Iowa.

ANTLIODUS SULCATUS, N. and W.

Pl. III, Fig. 5, 5 *a*.

TEETH of medium size, broad, thin, flattened, with an elliptical outline; posterior face long, elliptical, smooth, less than half as high as broad, slightly concave vertically, laterally straight, superior margin regularly arched, truncated, and slightly sulcated, sulcus about one-sixth the height of the face, its posterior margin lowest, both margins porous and roughened by the terminations of the vertical enamel tubes; coronal ridge regularly curved downward, narrow, not prominent, showing about three imbricating folds; posterior face broader than anterior, elliptical in outline, very slightly arched vertically and horizontally, rough; coronal ridge wanting; base narrow and roughened with the rudimentary root.

Much like the preceding species in general aspect but broader, thinner and more distinctly sulcate; anterior face more flattened.

Figures 5, 5 *a*, represent the posterior face and section, natural size.

Formation and locality: Keokuk limestone, Warsaw, Illinois.

GENUS DACTYLODUS, N. and W.

DACTYLODUS PRINCEPS, N. and W.

Pl. III, Figs. 6, 6 *a*, 6 *b*.

TEETH large and robust, slightly higher than broad; superior border of crown regularly arched, obtuse and porous; anterior face three-tenths of the height of the tooth, sloped downward at an angle of about 30°, to an obtuse transverse ridge, surface smooth and gently arched horizontally; posterior face imperfectly elliptical, nearly flat, smooth, in weathered specimens more or less porous, about twice as high as the anterior face, bounded below by a thick coronal ridge, obscurely marked with imbricating folds. This ridge is somewhat bow-shaped, terminating in the prominent lateral angles. The root is large and thick two-thirds the breadth, and nearly the height of the crown. Its posterior face is flattened, the anterior slightly arched both ways. It is divided nearly to the crown into five finger-like rootlets, of which the two external ones are shortest and most robust.

These remarkable teeth differ widely from any hitherto described, in the long fangs in which the root terminates; in this respect being more like the teeth of mammals than fishes. The crown, however, is essentially that of *Petalodus*, and there can be no doubt that they once belonged to a plagiostomous fish of the same family as the typical *Petalodi*.

Prof. McCoy has described some petalodont teeth, from the same horizon with these, under the name of *Polyrhizodus*, which also have roots divided into several fangs; and other similar species will be found represented in Pl. III, and described in the following pages. As will be shown hereafter, McCoy's *Polyrhizodus* has much in common with *Petalodus*. This affinity is also indicated by the species before us, and *D. lobatus*, both being still more like the teeth on which Owen founded his genus *Petalodus*; and yet they have larger and more distinct fangs.

The only specimen of *D. princeps* in the collection is, unfortunately, somewhat worn and weathered, and its external surface has been in part removed. It is, therefore, impossible to decide from that alone, whether in its normal state it exhibited any decided departure from *Petalodus*. It now shows near the summit of the crown a more porous structure than most species of that genus in their perfect condition. As has been remarked, however, in the description of *Petalodus destructor*, where the cutting edge of the crown is much worn, and the polished enamel coating of either face is removed, nothing but a dotted porous surface is seen; the longer calciguous tubes which compose the edge being removed or worn down, so that both there and below their ends alone are visible.

As has been suggested in the remarks on the genus *Petalodus*, we have scarcely satisfactory data on which to divide the petalodont teeth into different genera; the typical species, the many rooted, the small rooted and the rootless groups, all exhibiting among themselves nearly the same range of microscopic structure; this variation, when existing in perfect teeth, following their forms and consequently their uses. The broad-edged, grinding or crushing teeth of each group exhibit, in their triturating surfaces, the homologues of the cutting edges of the incisive forms; the series of vertical enamel tubes being greatly widened, and the tubes shortened.

The figures given of *D. princeps* represent (6) the anterior face; (6 *a*) the posterior do; and 6 *b*, the profile section; all natural size.

Formation and locality: St. Louis limestone, St. Louis, Missouri.

Dactylodus lobatus, N. and W.

Pl. III, Fig. 7, 7 *a*.

Teeth rather small, thin and flattened, crown elliptical, cutting edge regularly arched, posterior face smooth, in weathered specimens finely striated longitudinally, concave vertically, nearly straight horizontally; anterior surface two-thirds as high as posterior; posterior coronal ridge formed by the imbricating folds, bow-shaped, prominent, folds numerous, (5–6), sharp, fine and parallel; root half the height and half the breadth of crown, three lobed, lateral lobes acute, middle one larger and emarginate. Height 9 lines; breadth 10 lines; height of crown, including basal ridge, 6 lines; of root 3 lines.

The single specimen of this species contained in the collection, seems to be another connecting link between *Petalodus* of Owen, and *Polyrhizodus* of McCoy. The crown is apparently precisely that of a *Petalodus*, and the root, in its general form, is not unlike that of some *Petalodi*, except that it is deeply lobed. A tooth, generically, and it is possible, specifically, identical with the one before us, has been described by Prof. Leidy under the name of *Ctenoptychius digitatus*. (*Trans. Amer. Philos. Soc., Vol. XI, p.* 90, *Pl.* 5, *figs.* 27, 28, 29). Judging from the figures and description only of that tooth, we should say it was less symmetrical, the edge of the crown less thin and acute, the root longer and broader than in our specimens. These differences may prove, however, to be dependent on the places which they occupied in the mouth.

The peculiar and abnormal character of these teeth is strikingly illustrated by the fact that an anatomist of so great learning, and so proverbially accurate, as Dr. Leidy, should have reversed one of them, and have described as the crown, what is shown by the three well marked and closely allied species before us, to be the root.

Figures 7 and 7 *a*, represent the posterior face and section, natural size.

Formation and locality: St. Louis limestone, Alton, Illinois.

DACTYLODUS INFLEXUS, N. and W.

Pl. III, Figs. 8, 8*a*.

TEETH of small size, slightly broader than high; crown equaling the root in height; cutting edge sharp, regularly arched, unevenly striated and crenulated by the somewhat irregularly disposed marginal enamel-tubes; posterior face elliptical, strongly concave vertically, nearly straight laterally; anterior face throughout all its central portion plain and smooth, long-rhomboidal in outline, the upper and lower angles rounded symmetrically, the lateral ones long-pointed, the points being abruptly curved backward and downward to join the coronal ridges. This face of the crown is much elevated, forming an acute angle with the base; the anterior ridge dividing the crown from the base is prominent, but like the spaces bordering it very smooth. When worn, the anterior face of the crown shows near the upper border a somewhat reticulated porosity produced by the cutting across of the oblique enamel tubes. The root is flat, somewhat constricted at its junction with the crown, but expanded below and divided into 5–6 divergent and conspicuous radicles.

Though sufficiently distinct from the two preceding, this species is closely allied to them, forming the fourth with which we are now acquainted, of this interesting group. Its most distinctive character is that which suggested the specific name given it, in the strong backward inflexion of the upper part of the crown. This gives it the appearance of having a flat summit, and of being a grinding tooth. It has, however, a sharp, cutting edge, and its position on the jaw must have been such that the summit of the crown was vertical or slightly inclined toward the throat. The anterior face of the crown is worn near the edge as though a corresponding tooth in the other jaw had matched with this, and the two had worked together like the blades of a pair of shears.

The form and length of the root in many Petalodonts is such as to indicate that they could have had little motion, but were probably fixed in their places, and like these worked together in the manner of scissor blades.

Figure 8 and 8 *a*, represent the anterior face and profile, natural size.

Formation and locality: Chester limestone, Chester, Illinois.

GENUS POLYRHIZODUS, McCoy.

POLYRHIZODUS POROSUS, N. and W.

Pl. III, Figs. 9, 9*a*.

TEETH thick and massive, twice or three times as broad as high; posterior face of crown comprising nearly half the height of the tooth, long-elliptical in outline, with rounded extremities, strongly inclined backward toward the summit, very slightly concave both vertically and laterally, smooth in perfect specimens, marked with fine vertical striations in those that are weathered—in such, a narrow band of pores are visible along its lower margin; coronal imbricating folds forming a broad, flattened band, nearly as high as the crown face, laterally straight except near either end, where it is suddenly curved upward, folds three, of equal height, with two very fine lines below; anterior face nearly horizontal, forming a triturating surface of the same form and area as the posterior crown face, slightly concave and lower before. In unworn specimens this is covered with a coating of polished enamel, except at the posterior edge, where it is porous; when much worn the entire surface is distinctly porous, as in *Psammodus;* base as high as anterior crown face, to which it is inclined below, smooth throughout, convex vertically and laterally; root nearly as wide as the tooth, directed forward and downward, and reaching but little below the line of the posterior basal folds, divided into several distinct radicles.

The form of the crown of these teeth is similar to that of *Polyrhizodus magnus*, McCoy (loc. cit.), but they are smaller, have shorter rootlets, and a somewhat different profile; Prof. McCoy's species having the lower margin of the posterior crown face inclined backward, while in our species it is inclined forward, etc.

Figures 9 and 9*a* represent the posterior aspect and profile of the largest specimen in the collection, of the natural size.

Formation and locality: Burlington limestone, Burlington, Iowa, and Quincy, Illinois.

POLYRHIZODUS DENTATUS, N. and W.

Pl. III, Fig. 10, 10 *a*.

TEETH of moderate size, much broader than high, widest at summit; posterior surface of crown linear in outline, with rounded ends, less than half the height of the tooth, terminating above in an acute, porous, cutting edge, which is nearly straight throughout; posterior crown face somewhat concave vertically, nearly straight horizontally; basal ridge prominent, half the height of the crown face, straight in its central part, curved upward to the cutting edge at each end; anterior face of crown nearly as high as posterior, inclined to the vertical axis of the tooth at an angle of about 45°, straight or very slightly arched vertically, gently arched toward each lateral extremity, where it narrows to a point, terminating below in an acute edge, or angle without distinct coronal ridge or folds; base linear, as high as crown face, to which it is inclined at an acute angle, smooth, concave vertically, arched laterally; root thicker than crown, composed of numerous sub-quadrate radicles nearly half the height of the entire tooth.

It will be noticed that this tooth has a strong family resemblance to those we have described under the names of *Chomatodus multiplicatus* and *C. loriformis*, and through them is distinctly connected with the solid rooted Petalodonts, and yet the root is deeply, almost regularly, divided into numerous distinct radicles. In this respect it is like the following species, more particularly to the next one *P. ponticulus*. To *P. porosus*, which so closely approaches *Polyrhizodus magnus* of McCoy, it is allied by its divided root, and the generalities of its form; but its cutting edge and comparatively light and angular profile, render it distinguishable from that species at a glance. With its numerous sub-equal tooth-like radicles this tooth bears considerable resemblance to the jaw of some mammal with a series of attached teeth; a resemblance which has suggested the specific name given it.

Figure 10 exhibits the posterior face of the tooth; 10 *a*, is a profile section; both natural size.

Formation and locality: Chester limestone, Chester, Illinois.

POLYRHIZODUS PONTICULUS, N. and W.

Pl. III, Fig. 11 and 11 *a*.

TEETH broad, low and thin, in outline oblong or linear; posterior surface of crown two-thirds the entire height, concave vertically, nearly straight laterally, smooth and polished; imbricating folds forming a narrow, low basal band; anterior face nearly horizontal, giving a flat or slightly arched summit to the tooth, not quite half as broad as the height of the posterior face; basal ridge a sharp angle without distinct folds; base forming half the height of the anterior surface, concave vertically, gently arched laterally, smooth and polished; root vertical, nearly as broad as the tooth, and composing one-third of its height, flat, thin and divided into several sub-equal quadrangular rootlets. Height of tooth 4 lines; breadth of a portion only, 15 lines.

This tooth should evidently be classed in the same genus with McCoy's *Polyrhizodus magnus* (*Brit. Palæoz. Foss. p.* 641, *Pl.* 3 *k*, *fig.* 6, 7, 8), but certainly not with his *P. pusillus*, (*Op. Cit. p.* 642, *Pl.* 3, *k*, *fig.* 2.)

From the former it differs, however, in being lighter throughout, the more angular crown, shorter, fewer, and more angular roots. Its relations to the preceding species, *P. dentatus*, are much closer, that species differing from this only in being higher, the crown more acute above, the radicles more numerous and much thicker. In both these species the summit of the crown forms nearly a straight line throughout, the basal ridge being curved up to it at either end.

Figures 11, 11 *a*, represent the anterior aspect and profile, natural size. As will be noticed, this face of the tooth bears a striking resemblance to a many-arched bridge, a resemblance which suggested the name given it.

Formation and locality: Chester limestone, Chester, Illinois.

GENUS CHOMATODUS, Ag.

CHOMATODUS GRACILLIMUS, N. and W.

Pl. III, Fig. 12, 12 *a*.

TEETH transversely elongated, linear in outline; posterior crown face half the entire height with rounded ends, its upper and lower borders being straight and parallel throughout most of the breadth, but curved to meet at each end. The surface slightly concave and finely striated vertically, straight laterally; the upper margin showing a few relatively large pores; basal folds 3–4, forming a flattened band little more than half as high as the crown face; anterior surface nearly horizontal, forming a flat top to the tooth. This is a little narrower than the posterior crown face, lower before than behind, slightly concave in an antero-posterior direction; base broader than the anterior face, flat; root nearly as broad as the crown, very short, projecting but little below the posterior imbricated folds, more or less waved in outline, but scarcely divided.

This species bears considerable resemblance to *C. loriformis* in its general aspect, but is relatively broader and lower, has the crown more rounded at the ends, has a more nearly horizontal summit when viewed in profile, etc. It would seem also that some of the teeth described by Prof. Agassiz. (*Poiss. Poss. Vol.* 3, *p.* 108, *tab.* 12, *fig.* 5–12,) under the name of *Chomatodus linearis* were of similar form. There are probably several distinct species, however, included in the series represented by Prof. A., part of which should be included in *Antliodus*—as Fig. 5, which is considerably like our *A. parvulus*, and others perhaps in *Helodus*. The specimen represented by Fig. 6, (*loc. cit.*) evidently represents a species closely allied to ours, though the descriptions of *C. linearis*, by Agassiz and McCoy, prove it different. These represent the crown as *surrounded* by a line of basal folds, while in our specimens of *P. gracillimus*, as in all the group to which this species belongs the imbricated folds are scarcely, if at all, visible, except on the posterior face. The profile section of *Chomatodus linearis* is also quite different, the superior margin being much sharper.

Figures 12 and 12 *a* represent the posterior aspect and section, natural size.

Formation and locality: Burlington limestone, Burlington, Iowa.

CHOMATODUS CULTELLUS, N. and W.

Pl. III, Fig. 13, 13 *a*.

TEETH transversely elongate, thin and knife-like; central portions straight and flat, the ends strongly curved forward;

crown terminating above in a cutting edge which has an arched outline, more or less undulate and porous; posterior crown face more than half the height of the tooth, slightly concave vertically, arched laterally at either end; posterior basal folds about 3, forming a flattened band, half the height of crown face; anterior crown face a little less high than posterior, nearly straight vertically and laterally, except at the extremities, where it is curved forward, smooth and polished, but under the lens showing pores throughout; basal ridge narrow, distinct, straight, except at the ends, where it is slightly turned upward, without imbricating folds; root very nearly as wide as crown, less than half as high undivided, but marked along its anterior surface by a series of deep and nearly uniform pits or depressions, separated by narrow, prominent, vertical costæ; toward either lateral extremity the root is gradually narrowed, and here the costæ are somewhat divergent from the centre.

This species resembles the preceding one in many respects, but is readily distinguishable by its thin, flat crown, curved at either end, and by its thin, deeply pitted root.

Figures 13, 13 *a*, represent the anterior face of an imperfect tooth, with a profile section, of the size of nature.

Formation and locality: Chester limestone, Chester, Illinois.

CHOMATODUS PUSILLUS, N. and W.

Pl. III, Figs. 14, 14 *a*, 14 *b*.

TEETH small, slender, linear, broader than high; posterior face of crown half the entire height, linear or long-lenticular in outline, straight laterally, concave vertically, cutting edge sharp, fine, crenulated and more or less undulated, whole posterior face striated vertically, striation stronger along the edge, as in the typical Petalodonts; basal angle very prominent, showing two or three narrow enamel folds; anterior surface equaling posterior in height, of similar outline, slightly arched laterally, more strongly so vertically, smooth and polished throughout, but showing every where relatively large, evenly distributed pores; basal angle a prominent ridge opposite posterior one without distinct folds; root nearly as broad and high as the crown, vertically concave anteriorly, convex posteriorly, not divided.

In its general form this tooth approaches somewhat nearly to the three preceding species, but in the equal height of the basal ridges of the opposite crown surfaces, and in the porous structure of the anterior face it is allied to the *Helodi*, presenting an interesting link between these two genera.

Figure 14, represents the anterior aspect of a broken tooth; figure 14 *a*, the crown seen from above; and figure 14 *b*, a central profile section, natural size.

Formation and locality: Keokuk limestone, Nauvoo, Illinois.

CHOMATODUS AFFINIS, N. and W.

Plate III, Figs. 15, 15 *a*.

TEETH laterally elongated, 5–6 times as broad as high, thick and strong; posterior crown face oblong in outline, vertically and laterally concave, upper and lower borders nearly straight, slightly arched together at the ends; basal folds about 4, nearly equal, parallel and distinct, forming a prominent flattened ridge about one-fourth the height of crown face; anterior face linear in outline, narrowed to a point at each end, half the height of the posterior face, to which it is inclined at an angle of about 60°, slightly concave vertically; base very concave vertically, slightly arched laterally, forming a broad furrow between the root and anterior basal ridge. This furrow is narrower in the centre than at either end, made so by the slight arching upward of the line of insertion of the root, and downward of the coronal ridge; root nearly as broad as the tooth, forming only a prominent ridge not reaching down to the lower line of the posterior coronal band.

This species is represented in the collection by much worn teeth only. These have a marked similarity to *C. angularis* from the Coal Measures at La Salle, and at first sight will perhaps not be distinguished from it; closer inspection will, however, enable one to separate them. In *C. affinis* the posterior imbricating folds are fewer, forming a narrower band which is not so distinctly turned up at the ends. The base, too, is very much more concave.

Figure 15 and 15 *a*, represent the posterior aspect and section of an imperfect tooth, natural size.

Formation and locality: Keokuk limestone, Appanoose, Illinois.

CHOMATODUS ANGULARIS, N. and W.

Pl. III, Figs. 16, 16*a*.

TEETH laterally elongate, broader than high, oblong in outline, thick and strong; posterior crown face little more than half the height of the tooth; linear in outline, the superior border straight, forming an obtuse or truncated triturating edge, concave vertically, straight laterally, smooth below, porous above; posterior basal folds about ten, the upper much the broadest, forming a flattened band nearly as high as the crown face. These folds are straight throughout all the middle portion of the tooth, but are suddenly turned up at either end toward the straight upper margin; anterior crown face linear, half the height of the posterior surface, toward which it is inclined at an angle of about 60°, concave vertically, straight laterally; anterior basal folds about three, in a flattened ridge half the height of the crown face; base nearly flat and smooth, forming a plane at right angles with the anterior crown face; on this plane the rudimentary root is placed as a prominent ridge, not reaching down to the lower line of the posterior basal folds.

Though closely allied to the succeeding species, *C. molaris*, this exhibits very important and distinctive differences. It is more angular in all its parts. The root is smaller, the posterior basal folds much more numerous, the angle included between the crown faces different, and the triturating surface is formed by this truncated angle, rather than by the arched anterior crown surface. Its position on the jaw must therefore have been different, and its broader surfaces more nearly horizontal.

Figures 16 and 16*a* represent the posterior aspect of a broken tooth and a section, natural size.

Formation and locality: Coal Measures, LaSalle, Illinois.

CHOMATODUS MOLARIS, N. and W.

Pl. III, Figs. 17, 17*a*.

TEETH thick and strong, broader than high, outline linear or oblong, with nearly parallel sides; posterior face of crown half the entire height, concave vertically, straight laterally, smooth; posterior basal folds 2–3, forming a prominent band or ridge nearly half the height of the crown face; anterior surface narrower than posterior, forming an arched summit, of which the posterior margin is scarcely higher than the anterior; in worn specimens it is lower; along the anterior border of this surface is a shallow sulcus, dividing off a narrow line, which forms the representative of the usual basal folds. The triturating surface formed by the homologue of the anterior crown face, when much worn, shows a few large pores, but in preparation for the severe service to which they were exposed, the entire teeth were exceedingly close and compact in texture, and the surfaces are all smooth and polished. The base is concave vertically, straight laterally, strongly inclined below toward the posterior face, giving a V-shaped section to this part of the tooth. The root is strong but short, reaching little below the line of the posterior basal folds.

This may be regarded as the type of a small group of species, represented in the collection by a large number of specimens, most of which are, however, too imperfect for description. They exhibit the *petalodont* type of structure throughout, but in their laterally elongated form, their truncated summits, they approach very nearly to the teeth of some of the rays, and it is evident that their functions were the same as those of the teeth of the *Myliobatini*, *i. e.* they were employed in crushing shells, corals and other resistant substances, for which both strength of form and great hardness were required.

Figures 17 and 17*a* represent a fragment of a worn tooth; basal surface and section natural size.

Formation and locality: Keokuk limestone, Warsaw, Illinois.

CHOMATODUS MULTIPLICATUS, N. and W.

Pl. III, Figs. 18, 18*a*, 18*b*.

TEETH very broad and low, four times as broad as high; posterior aspect showing three nearly equal parallel bands, the crown, the basal folds and root; the posterior face of the crown is linear in outline, rounded at either end, its upper and lower borders nearly straight. The surface is smooth and polished, the cutting edge acute and very finely crenulated by the fine marginal striation of the anterior face; basal band of imbricated folds turned up and slightly rounded at either end, projecting beyond the crown, enamel folds numerous (7–8), flattened, the upper ones slightly widest; anterior face of crown strongly deflected backward, but little narrower than the posterior, concave vertically, gently arched laterally, its superior border beveled off to form the cutting edge, the beveled face being very finely striated vertically; anterior basal ridge prominent, narrow, showing about three folds; base smooth, narrow; root as high and nearly as broad as the crown, quadrangular; its posterior face retreating, its anterior and higher surface beveled off from the middle down to an acute edge, everywhere roughened and pierced by the foramina of the nutrient vessels; entire height, 6 lines; breadth, 24 lines; height of crown, basal folds, and root on posterior face, each 2 lines.

It is to be regretted that this very interesting and distinct species is represented in the collection by a single specimen only. Its very unusual breadth separates it widely from the typical *Petalodi*, and yet, in other respects, it is apparently like them. This, in itself, however, would indicate peculiarities of the dentition, at least of the size, form and arrangement of the teeth in the jaws of the fish possessing them, which, if we could define it, would serve as a satisfactory basis for the description of the genus. It is but fair to suppose that between the fishes bearing the narrow, the broad, the sagittate, the oval, the linear and the quadrate teeth, included in the *Petalodont* family, there were at least as great differences as between *Myliobates*, *Ætobatis*, *Zygobatis* and *Rhinoptera*.

It will be noticed that in the present species we have the linear form of many of the polyrhizoid group, and a root which is only a mass of consolidated rootlets, and which seems just ready to divide into distinct radicles, and yet its section presents the sharpest cutting edge and the most angular outline of any of the series. It thus forms a connecting link between its most dissimilar associates and illustrates the difficulty of separating them.

Figures 18, 18*a* and 18*b* represent the posterior face, a part of the anterior aspect and a central profile section—all natural size.

Formation and locality: Burlington limestone, Burlington, Iowa.

CHOMATODUS LORIFORMIS, N. and W.

Pl. III, Figs. 19, 19*a*.

TEETH very broad, thin, strap-shaped, with parallel margins and rounded at the extremities; cutting edge straight throughout the greater part of its length, curved downward at either side, sub-acute, porous; posterior face of crown comprising two-thirds the entire height of tooth, slightly curved vertically, straight laterally, smooth and polished; posterior coronal imbricating folds about 4, low but distinct, the upper ones widest, forming a band half the height of the crown face; anterior face half the height of the posterior, to which it is inclined at an angle of about 45°, straight or slightly concave vertically; coronal ridge a sharp angle, without distinct folds of enamel; base occupying more than two-thirds of the anterior surface of the tooth, slightly concave vertically; root nearly as broad as the tooth, very short, extending but little below the posterior basal folds, rounded in profile, roughened, not divided.

The only specimen of this species which exists in the collection is broken at one end, and does not therefore give the entire breadth. The height is 4½ lines. The breadth of the fragment, 17 lines. The total breadth could not have been much less than 2 inches.

In its general aspect this tooth is much like the last described. Like that, its disproportionate breadth renders it very unlike the teeth of any of the true sharks of which we have any knowledge. The Rays and some Cestracionts have equally broad teeth, but these all have flat or obtuse summits, fitted for grinding or crushing; none of the incisive teeth of the carnivorous sharks having anything like an equal relative breadth. It would be a matter of great interest to ascertain, if it were possible, what was the position of these broad, knife-like cutting teeth in the mouths of their possessors; whether they were set transversely across the symphysis of the jaws, as in the *Myliobatini*, or on the rami of either side, as in the *Cestracionini*.

Their perfect symmetry would rather indicate a medial position like the broad teeth of the rays. Whether in this case they formed a single series, as in *Ætobatis*, or were associated with narrower lateral teeth, as in *Zygobatis* and *Myliobates*, we may perhaps never know, as the cartilaginous jaws on which they were set have usually been wholly decomposed and the teeth scattered.

Figures 19 and 19*a* represent the face and profile, natural size.

Formation and locality: Keokuk limestone, Warsaw, Illinois.

GENUS DIPLODUS, Ag.

DIPLODUS LATUS, Newb.

Pl. IV, Figs. 1, 1*e*.

Diplodus latus, *Newb.*, *Pisc. Phil. Acad. Nat. Sci.*, 1856, p. 99.

TEETH large and robust; base thick and massive, elliptical in outline, flattened below, with a large, obtuse tubercle projecting downward and forward at the anterior margin; posterior end rounded; central cusp rudimentary or obsolete; lateral denticles unequally divergent in the same plane, very robust, 2–3 times as high as broad at base, smooth and polished throughout, compressed, with a lenticular section, and sharp, crenulated, cutting edges, extremities sharp, but scarcely pointed.

This is a large and robust species, the larger specimens being 9 lines high; the extremities of the lateral cusps being separated by an equal interval. Unlike *D. gibbosus*, Ag., and *D. gracilis*, Newb., the lateral denticles diverge in the same plane, which is vertical to the antero-posterior axis of the base.

Among the specimens which I have been inclined to refer to this species, considerable diversity of size and form may be noticed, and it is by no means certain that they should be regarded as specifically identical. Of these the largest constitute the true type of the species, as first described. They are characterized by the great strength of the lateral denticles, which are scarcely twice larger than wide at base, and nearly of equal length, accurately set in the same vertical plane. Another group, little smaller than these, are however sensibly more slender. The lateral denticles, though as long, are narrower and scarcely compressed at base. The anterior tubercle is much more prominent, and the posterior portion of the base has a vertical groove in the edge, at the mesial line, and above this a broad, flattened, circular tubercle, which is roughened on the upper surface, as though it was the place of a muscular attachment. A similar character is shown in the magnified figure of *D. gibbosus*, Ag. (*Poiss. Foss. Atlas*, *Vol.* III, *Tab.* 22 *b*, *fig.* 4), but there the flattened tubercle is represented as though placed in apposition with and between the bases of the lateral denticles. In all the specimens before me it is separated from the cusps by a space equal to its own diameter, which is about 2 lines. In these two groups, which I have hardly been willing to separate specifically, the central cusp is either entirely obsolete or reduced to a small conical tubercle.

Another group of teeth, which are not rare in the Coal Measures of Ohio, is represented in the collection by two specimens only. These I have formerly designated by the name of *D. compressus*, though it is possible they should be regarded as merely a variety of *D. latus*. They are, however, not more than half the size of the teeth of that species. The base is relatively smaller, the cornua more unequal, acute and compressed; one of the pair—the right or left, according to the position of the tooth in the mouth—being much narrowed toward the point and sigmoidally curved. In this group the margins of the denticles are more distinctly crenulated. (See description of *D. compressus.*)

Figures 1 and 1 *e*, side views; 1 *a*, 1 *b* and 1 *c*, anterior faces of different specimens; 1 *d*, posterior face—all natural size.

Formation and locality: Coal Measures, Posey county, Indiana, and Columbiana county, Ohio.

DIPLODUS COMPRESSUS, Newb.

Pl. IV, Fig. 2.

Diplodus compressus, *Newb.*, *loc. cit.*

TEETH smaller and more slender than those of *D. latus;* about 5–6 lines high, and having a space of 4 lines between the points of the denticles; base small, 3 lines long, 2½ broad, lateral denticles narrow, compressed and crenulated, generally unequal in length and unlike in form; the anterior? one being longest, divergent at a greater angle, long-pointed, acute, doubly-curved, 4–5 times as long as wide; the posterior? one straight or falcate and relatively broader; the median denticle, when visible, short, acute, compressed and crenulated.

Figure 2, inner surface of large specimen, natural size.

Formation and locality: Coal Measures, Posey county, Indiana, and Linton, Ohio.

DIPLODUS DUPLICATUS, N. and W.

Pl. IV, Figs. 3, 3*a*.

TEETH small, slender; base relatively small and thin; denticles four, sub-equal, conical, divergent, curved, somewhat striated longitudinally, with circular or sub-circular section, terminating in acute points; entire altitude of tooth about 3 lines, length of denticles 2 lines, spread of the most divergent 4 lines.

In the number of denticles this tooth differs so much from the species of *Diplodus* heretofore described, that there may be some doubt whether it should be included in the same genus with them. Its structure, however, is on the whole much like that of *D. gibbosus*, *D. gracillis*, etc., the only striking difference being that this has four cornua, while they have two or three. The number of denticles is, however, not constant in the genus—in the species I have enumerated, the medial one being sometimes half the length of the two lateral ones, sometimes reduced to a mere tubercle and sometimes even wholly obsolete. Prof. Agassiz mentions having seen as many as five denticles attached to one root, (*Poiss. Foss.*, *Vol.* 3, *p.* 204.)

In the figure of *D. minutus* (*Atlas*, *Vol.* 3, *Fig.* 7, *Tab.* 22*b*) four denticles are seen lying nearly in contact, and perhaps may have been connected with the same root. Should it prove, however, that there were sometimes four denticles on the tooth of that species, ours would still be distinguished from it by its much more slender and awl-like cones.

Figure 3 shows the posterior? aspect of an entire tooth, natural size; figure 3*a*, the opposite face of the same, enlarged to two diameters.

Formation and locality: Keokuk limestone, Nauvoo, Illinois.

DIPLODUS INCURVUS, N. and W.

Pl. IV, Fig. 4, 4 *a*.

TEETH small; base large, thin, somewhat spoon-shaped, smooth. From one extremity of this, spring three sub-equal, recurved, divergent, conical denticles. These have a nearly circular section, with a faint lateral angle formed by a fine longitudinal carina; the anterior face of each being somewhat flattened.

But a single specimen of this singular tooth exists in the collection, and that somewhat broken. Enough of it remains, however, to make out its form fully, and to show its entire distinctness from any species before described. Its peculiar character will be seen at a glance by reference to the figures which we give of it. Length of base, 3 lines; breadth in widest part, 2 lines; length of denticles, 1¼ lines.

Figure 4 represents the anterior aspect of the tooth; figure 4 *a*, the side view, magnified to two diameters.

Formation and locality: Keokuk limestone, Nauvoo, Illinois.

GENUS ORODUS, Ag.

GEN. CHAR.—"Teeth laterally elongated, having their middle portion more elevated than their extremities, forming in the central portion of the tooth an obtuse and transverse cone; the longitudinal diameter, which much exceeds the transverse, is also marked by a ridge sometimes medial, sometimes submedial, from which spring oblique secondary ridges which ramify upon the sides, and which, in the larger teeth, give rise to another series of collateral ridges."

The genus *Orodus* has not been before recognized in America.

ORODUS? MULTICARINATUS, N. and W.

Pl. IV, Fig. 13, 13 *a*.

TEETH very large, thick and massive, central portion forming a broad, obtuse cone, from which radiate numerous fine but prominent carinæ. From these spring a great number of simple or branching secondary ridges, which spread over all the surface of the crown. These ridges are sharp and well defined, and are separated by obtuse furrows of about double their width; both ridges and furrows highly polished and uniformly punctate.

It unfortunately happens that this remarkable species is represented in the collection by a single specimen only, and that a fragment, a portion broken from the centre of the tooth; the margins being gone, carrying with them all data for determining its size or form. It is evident, however, that it must have been equal if not superior in size, to any other tooth in the collection. At least 2 inches wide in its narrowest part. The microscopic structure and style of ornamentation are very similar to those of the large and beautiful teeth described by Agassiz. (*Poiss. Foss. Vol.* 3, *p.* 97, *Atlas, Vol.* 3, *Tab.* 11, *fig.* 5–9), under the name of *Orodus ramosus*, and it is not improbable that we have in this fragment the central cone of the tooth of a species of *Orodus*, perhaps generally similar in form to *O. ramosus*, but considerably larger and more highly ornamented.

Figures 13, 13 *a*, are top and side views, natural size.

Formation and locality: Kinderhook group, "Goniatite bed," Rockford, Indiana.

ORODUS PLICATUS, N. and W.

Pl. IV, Fig. 5.

TEETH small, laterally elongated, slender, somewhat arched; crown bearing a sub-medial prominent cone, with 4 or 5 lateral ones. The central cone is rounded, sub-acute, its summit marked by numerous fine radiating striæ. On either side a beaded crest runs down to and over the lateral cones; lateral cones small, not crowded, from their summits one or two prominent, acute, divergent costæ, descend on either side to the base of the crown, much stronger on one side than the other; base of the median cone and the entire surface of the lateral portions of the crown on one side, ornamented with numerous, fine, but distinct, horizontal lines or folds. On the opposite surface these are nearly obsolete.

This slender and highly ornamented species, though presenting a general similarity to several of the preceding group, may be at once distinguished from them by the numerous fine horizontal lines which cover one face of the crown.

Figure 5, 5 *a*, side view of a broken specimen, twice the natural size.

Formation and locality: St. Louis limestone, St. Louis, Missouri.

OKODUS ELEGANTULUS, N. and W.

Pl. IV, Figs. 6, 6 *a*.

TEETH small, laterally elongated, narrow and slender; crown conical, bearing a prominent central cone, from which the outline slopes away to either extremity. The median cone is faintly marked with a few delicate radiating raised lines. On either side of this are six or eight small tubercular secondary cones, from each of which spring about three raised lines, which diverge and cover most of the anterior face of the crown; this line of prominent points is not medial, but nearer the posterior than anterior border. The posterior face of the crown is somewhat roughened with short, tortuous, raised lines and tubercles. The crown is covered with a coating of dense translucent enamel, highly polished, and without pores. The root seems to have been cartilaginous, and has usually disappeared.

This elegant little species bears considerable resemblance to the last, but is somewhat larger and much smoother; the raised lines which ornament the surface of the crown being comparatively few and faint, and having a different arrangement. When seen on profile it exhibits some resemblance to *O. cinctus*, Ag., but on close examination it will be seen that the ornamentation is quite different. In *O. cinctus* the median cone, as well as all the lateral prominences, are unbroken rings which arch over from the front to the rear, while in our species the central elevation is distinctly, sometimes acutely, conical, marked with radiating lines. The secondary tubercles are round, smooth, and distinct, and from these, three or four sharp, raised lines, diverge to cover one side only of the crown, constituting a much more complex and beautiful style of ornamentation.

Figure 6, 6 *a*, represent the top and side view of a medium specimen, natural size.

Formation and locality: Burlington limestone, Burlington, Iowa.

ORODUS ORNATUS, N. and W.

Pl. IV, Figs. 7, 7 *a*, 8, 8 *a*.

TEETH small, laterally elongated, with a prominent central cone, and a more or less conical outline; crown highly ornamented with numerous prominent carinæ. Of these, ten or more radiate from the summit of the central cone, covering its sides with their tortuous branches. From the central cone a sharp and prominent crest runs down to either extremity along the median line. In some specimens this crest is broken up into numerous small, lateral cones, which are ornamented like the principal one, with radiating carinæ. In other specimens these secondary cones are scarcely developed, but the crest is serrated, when seen in profile, by the outlines of the numerous ridges which cross it. The root is usually slightly narrower than the crown, and of equal height, coarse, and porous. A transverse profile shows it to be in most specimens oblique to the crown.

These are highly ornamented teeth, the crown being elaborately sculptured in every part. They vary much in size, and somewhat in form, the larger ones being laterally long and narrow, from 6 to 7 lines in length, while the smaller ones are half as long, but thicker in the central part; when seen from above often presenting a sub-triangular outline. By their general aspect they remind one of *Orodus cinctus*, Ag., (*Op. Cit. p.* 96, *Tab.* 11, *fig.* 1–4,) but they are much smaller, and the ornamentation is more elaborate and of a different pattern.

Figures 7 and 7 *a*, represent a larger and smaller tooth, each viewed from above, magnified to two diameters. Figures 8 and 8 *a*, crown and side view of another small specimen, natural size.

Formation and locality: Keokuk limestone, Warsaw and Nauvoo, Illinois.

OKODUS TUBERCULATUS, N. and W.

Pl. IV, Figs. 9, 9*a*.

TEETH small, short, high, conical in outline; median cone relatively large, pointed, sometimes acute; lateral cones rudimentary, nearly obsolete, two or three on either side of the principal cone, rapidly diminishing, together forming pointed lateral appendages to the central prominence; central cone bearing several prominent ridges, strongest at the base, fading out at the summit; similar ridges upon the lateral extremities in pairs form the rudimentary secondary cones. On the inside the ridges are less distinct, and are in part represented by enameled tubercles; whole surface of crown polished, and without pores.

The species before us bears a strong resemblance to the preceding one, and indeed to all the smaller species which we have described. It is, however, apparently distinct from all, and may be recognized by its relatively short and high figure, the preponderance of the central over the secondary cones, by its few, strong, ornamental ridges, frequently represented by mere tubercles, etc.

Figure 9, crown face seen from above; 9 *a*, side view, both twice natural size

Formation and locality: Burlington limestone, Quincy, Illinois.

ORODUS MAMMILLARIS, N. and W.

Pl. IV, Fig. 10, 10*a*.

TEETH small, laterally elongate, slender; crown arched or sub-conical, having a prominent median cone, with a series of 2–5 lateral cones on either side; median cone round, as broad as high, the lateral ones more or less appressed and flattened vertically. All these cones are ornamented with numerous, prominent, *often beaded* ridges, which are strongest at the base and fade out toward the summit on the median and some of the lateral cones. On those near the extremities they meet above. These ridges are strong and rounded; there are about four on either side of the lateral cones and twice as many upon the central one. The root has, on the inner side, an altitude one-third less than that of the crown, there presenting a vertical, coarse and porous surface. From the lower border of this the inferior surface slopes up to the corner on the opposite side.

In size and general character the species may be compared with the two preceding, but in the details of its structure is still quite different from either. From *O. ornatus* it may be at once distinguished by its very distinct lateral cones, which are separated by deep sulci, and, like the middle one, are constricted at the base; the ridges coarser and more obtuse, and more restricted to the base of the crown.

From *O. elegantulus* it may be easily separated by noticing its more conspicuous lateral cones—its stronger ornamentation occupying the base of the crown on either side, while in *O. elegantulus* it is mainly restricted to the summit and one face.

In the specimens contained in the collection we have one on which are more than a dozen teeth, that apparently belonged to a single individual. It is therefore of special interest as affording a little of the information so rarely obtained in reference to the variety of form displayed in the dental series of a single plæozoic fish. Unfortunately this specimen is much weathered, and all finer markings are obliterated. We can see, however, that there was considerable diversity of size and some difference of form among them, there being longer and shorter ones, those nearly straight and those strongly arched, those with conspicuous roots and those with little or none, and finally those relatively thick and strong and others very slender. The surface marking is, however, as far as it has been preserved, essentially the same in all. Many of these teeth were apparently much worn during the life of their possessor, and it is evident from their condition, as well as from other facts which have come under our observation, that the subsistence of *Orodus* was made up, for the most part, of mollusks or other resistant substances, which it was necessary to crush, and in triturating which their teeth were much worn and impaired.

Figures 10 and 10*a*, side and top views, natural size.

Formation and locality: Keokuk limestone, Nauvoo and Warsaw, Illinois.

ORODUS MINUSCULUS, N. and W.

Pl. IV, Fig. 11.

TEETH very small, arranged in a series of five or more, diminshing in size from front to rear, their summits forming an arch in the same direction; each individual tooth laterally elongated, slender, somewhat arched in outline, strongly so in profile; crown smooth and highly polished throughout, forming an angular ridge, crowned with numerous prominent, bead-like points. Of these the largest is nearer one end than the other; from this point the secondary cones diminish in size to either extremity; lateral length of longest tooth 3 lines; of shortest, 1 line; breadth about half a line.

The teeth which form the basis of the foregoing description retain the relative position which they occupy on the jaw. Like most of the teeth of the genus, they are laterally unsymmetrical, the median cones not being placed on the central point of their longest diameter. Though very minute they are neat and exact in their forms and markings, and undoubtedly are the only traces yet discovered of an entirely distinct species of fish which inhabited the Carboniferous seas.

Figure 11 represents the series of teeth described above, magnified to two diameters.

Formation and locality: Keokuk limestone, Warsaw, Illinois.

ORODUS MINUTUS, N. and W.

Pl. IV, Fig. 12.

TEETH very small, forming a series of four or more, increasing in size from behind forward; each individual tooth laterally elongated, linear in outline, rounded at one extremity, apparently obliquely truncated at the other; crown forming a semicylindrical ridge, with a median cone nearest the truncated end. This is worn down in the specimens before us, and its form and relative elevation cannot be determined. The lateral surfaces of the crown exhibit no secondary cones, but the median line is marked by a fine, sharp crest, giving off, nearly at right angles, simple or forked thread-like carinæ, which run down to the base.

This species resembles *O. ornatus* and *O. elegantulus* more than any others described, but the crown of *O. ornatus* is less straight and symmetrical in outline, and the raised lines which ornament it are very tortuous and irregular—the larger ones giving off numerous short lateral branches, which give them a pectinated appearance, nothing like which is observable in the species before us. In *O. elegantulus* a line of bead-like tubercles crown the medial crest, the lines of ornamentation running down upon one side only, while in *O. minutus* both faces of the crown are ornamented. In size the teeth of this species are intermediate between *O. ornatus* and *O. minusculus*.

Figure 12 represents two teeth of a series of four, seen from above, twice the natural size.

Formation and locality: Keokuk limestone, Nauvoo, Illinois.

GENUS CARCHAROPSIS, Ag.

CARCHAROPSIS WORTHENI, Newb.

Pl. IV, Figs. 14, 14*a*.

BASE semi-elliptical in outline, irregularly, coarsely but not deeply scolloped, thick, flattened below, sloped off to the edges above, slightly broader than the entire height of the tooth; median cone conical, its height about equal to its width, measured across the upper surface of the expanded base; anterior face flattened, posterior regularly rounded, entirely smooth throughout; margins strongly and evenly crenulated from the apex to the base; lateral denticles two on either side, the exterior pair largest, about one-quarter the length of the median cone, situated a little back from the anterior margin, on the extreme points of the base, conical, acute and smooth, and slightly divergent from the axial line of the principal cone; second pair slightly in advance of and within the largest secondaries, scarcely more than tubercles. Breadth of base, 1 inch, 2 lines; height, apex slightly worn, 1 inch.

The beautiful tooth from which this description was taken is the first of the genus, so far as we know, that has ever been found on the American continent. Partially covered by the stone it had the appearance of *Cladodus*, but presenting some peculiarities, was carefully developed when the elegant crenulation of its margin showed itself, and its affinity to the teeth upon which McCoy founded the genus *Pristicladodus*, at once suggested itself.

This species fully confirms McCoy's view of the classification of the teeth to which he gave this name, (*Brit. Palæoz. Foss.*, *p.* 642.) With the one before us there are now three species known, which, with striking departures from all other types, have certain common characters, uniting them in a most natural generic group.

The name selected by McCoy for the genus also seems well chosen, for while the broad, semi-circular, thickened bases of these teeth and their lateral denticles, of which the exterior pair are largest, show their intimate relationship to those of *Cladodus*, the broad, semi-conical, crenulated median cone, which occupies nearly the entire breadth of the base, and so entirely overshadows the lateral denticles, gives the group a *facies* quite distinct from that of *Cladodus*, and show it to be a kind of connecting link between the *Hybodonts* and the *Carcharodonts*. McCoy's name was, however, anticipated by perhaps the equally appropriate one of *Carcharopsis* of Agassiz.

The crenulation of the edge of the median cone in *C. Wortheni* is remarkably regular and distinct, and is continuous from the summit down to the lateral denticles. The apex of the principal cone is somewhat worn, but was apparently quite sharp. The anterior surface is not accessible, but is evidently flattened, as in *P. dentatus*, McCoy, and somewhat excavated.

Figures 14 and 14*a*, posterior aspect and side-view—natural size.

Formation and locality: Sub-carboniferous limestone, Huntsville, Alabama.

GENUS PETRODUS, McCoy.

PETRODUS OCCIDENTALIS, N. and W.

Pl. IV, Figs. 15, 15*a*, 15*b*, 16, 16*a*.

BASE sub-circular or elliptical in outline, flat or slightly concave below, thin, terminating in an abruptly sharpened, finely crenulated edge, broader than the crown; crown broadly conical, acute or rounded at the summit, with a sub-circular or elliptical section, constricted at the base, marked with a variable number of strong, divergent ridges, many of which are forked below; ridges generally smooth, but sometimes more or less rugose.

This species is so much like *P. patelliformis*, McCoy, (*Palæozoic Fossils, p.* 637, *pl.* 3, *G. figs* 6, 7, 8,) that I have hesitated to consider it distinct. In *P. patelliformis*, however, the radiating ridges of the crown are represented by Prof. McCoy as being always strongly sulcated transversely, almost pectinated in fact, while in the great number of specimens in the collection none exhibit this character; a slight rugosity, rarely visible, is the only approach to it.

Prof. Agassiz has suggested that these bodies were not *teeth*, but the dermal tubercles of some of the ancient sharks. This supposition is rendered probable by their resemblance to the cretaceous tubercles of living plagiostomous fishes, particularly the Rays, and by some peculiarities of their structure as compared with other teeth. It will be seen that the base is exceedingly thin and very flat, much more so than in the teeth of any of the *cestracionts*, and too much so, we might suspect, for the requisite solidity and stability of teeth of which the function was the crushing of resistant substances. The base is, also, not only thin and weak, but laminated on every side in a thin, sharp, finely crenulated edge. This shows that if teeth, they must have been isolated and nowhere in contact with each other. In these respects they offer a strong contrast to *Orodus*, *Acrodus*, *Ptychodus*, etc., to which they have otherwise considerable resemblance. In all these genera the bases of the teeth are much thicker, and of forms that prove them to have been in contact with each other, and even matched together with a kind of pavement.

The extreme probability of the suggestion of Prof. Agassiz will be at once seen by reference to the figures which he gives of a fossil ray from the Lias of Lyme Regis, (*Poiss. Foss. Atlas, Vol.* 3, *pl.* 42, 43,) the dermal tubercles of this fish (*Squaloraja polyspondyla*) exhibiting a marked resemblance to those bodies called *Petrodus* by Prof. McCoy, and considered by him to be teeth.

There is great variation in form and size in the large number of these fossils included in the collection, some being ten times as large as others, some circular and some long-elliptical in outline, some being acute at summit and marked with sharp divergent ridges, others nearly smooth, as though much worn. With the exception, however, of that which formed the basis of the succeeding specific description, they should probably be all regarded as the exuvæ of the same species of fish. A large, sub-triangular, nearly smooth specimen, from the Coal Measures of La Salle, exhibits some peculiarities which may have a specific value. Without further evidence, however, we should hardly be justified in regarding it as distinct from those we have designated by the name of *P. occidentalis.*

Figures 15, 15*a* and 15*b*, top and side views of two teeth; 16, 16*a*, another tooth, perhaps specifically distinct.

Formation and locality: Coal Measures, Belleville, Illinois.

PETRODUS ACUTUS, N. and W.

Pl. IV, Fig. 17.

THERE is in the collection a single specimen of *Petrodus* that is derived from a different locality from the others, and which is so unlike them as to justify its separation from them. It is small in size, elliptical in outline, and the carinæ of the surface do not radiate from a central point, but the line of the longest diameter is marked by a prominent, acute crest, from which 4–5 pairs of acute, simple ridges are given off pinnately running down to the base. All the carinæ are, as compared with those of *P. occidentalis*, much sharper.

Figure 17, a small specimen seen from above, twice natural size.

Formation and locality: Coal Measures, Pike county, Illinois.

GENUS CTENOPTYCHIUS, Ag.

GEN. CHAR.—Teeth small, highly polished, strongly compressed, rounded or obtusely pointed, edge divided into several strong denticulations; base of crown with a few imbricating folds of ganoine; bony root oblong, flattened in the same direction as the crown.

It is very apparent that the species which have been referred to *Ctenoptychius* require separation; as, for example, *Ct. apicalis*, Ag., can hardly belong to the same genus with *Ct. serratus* of Owen; but we have not now the material for a discussion of the question of which should retain the name of *Ctenoptychius*.

CTENOPTYCHIUS SEMICIRCULARIS, N. and W.

Pl. IV, Figs. 18, 18 *a*, 18 *b*.

TEETH of median size; crown very thin, much compressed, and laterally curved, when viewed from above in outline forming a full semi-circle; anterior and posterior surfaces smooth and highly polished, without striæ or pores; superior margin forming a sharp, cutting edge, divided into numerous lobes, of which the middle one is largest, the others diminishing successively, to the lateral angles. These lobes are usually unequal in number on either side of the largest one, four on one side and five on the other. They are generally rounded in outline but sometimes acute. The anterior and posterior surfaces of the crown are of nearly equal height, the anterior sometimes showing a basal ridge as in *Petalodus*. The root is thicker than the crown and higher, nearly or quite as broad and of a somewhat similar form, except that its border is not scolloped. Both faces of the root are more or less roughened. On the posterior surface the root at its junction with the crown forms a broad shoulder, which is depressed at the centre with a deep, conical cavity. This gives to the profile section much the character of that of some species *Petalodus*, as will be seen by a reference to the figures.

When viewed from the front or rear the outline of these seems strikingly like that of the teeth of *Ct. apicalis*, Ag., as given by Agassiz, *Poiss. Foss. Atlas*, *Vol.* 3, *tab.* 19, *fig.* 1, 1*a*. Yet it would seem that in fact these forms are so widely different that it is even doubtful if they should be included in the same genus. *Ct. apicalis* is described as "transversely ovate," and judging from the figures and description of Agassiz and McCoy must be somewhat similar in general aspect to *Chomatodus dentatus*, McCoy, while the teeth before us are thinner and more curved laterally than in any species of *Petalodus*. *Ct. serratus*, Owen, (*Brit. Palæoz. Foss. p.* 626, *Pl.* 3–1, *fig.* 21, 22, 23), is, however, more like our species in general form, but is less curved and has nearly thirty denticles on the cutting edge, while in *Ct. semicircularis* there are but seven or eight.

The affinity of this species of *Ctenoptychius* with *Petalodus* will be seen by reference to the figures, to be very marked. McCoy has noticed this relationship in his description of *Ct. serratus*, which would be considered a *Petalodus* were it not for the coarse crenulations of the cutting edge. M. Agassiz compares *Ct. apicalis* to a small, compressed *Orodus*, which it is certainly very like, but it is evident that the present species is more closely allied to *Petalodus* than *Orodus*, and is in fact the most exaggerated form of lamillar and arched type of teeth first and best known by the former name.

Figure 18, anterior crown face; 18 *a*, same seen from above; 18 *b*, from the side.

Formation and locality: Coal Measures, Posey county, Indiana.

GENUS HELODUS, Ag.

GEN. CHAR.—"Transversely elongate, crown convex, elevated along the middle into an obtuse, conical ridge, sometimes divided into a line of several compressed cones diminishing from the centre; surface porous, as in *Psammodus*; margin of the crown raised in the middle on both the inner and outer sides, and it and the root vertically plicated."

It is evident that among the species at present included in the genus *Helodus* there is much incongruity, and the whole group requires a thorough revision and more or less sub-division, before anything like a distinct idea can be conveyed of a generic character represented by the name *Helodus.* Still the time has, perhaps, not yet arrived, when the required revision can be satisfactorily performed. The number of species which have been described is now about a dozen, and there are in the collection before us at least an equal number, which would be grouped with them in the genus *Helodus* as at present defined. Of these as we shall be able to show that some are probably nothing more than the median teeth of the jaws which bore on their rami the convoluted plates known as *Cochliodus*, while others having a general similarity of form, with these apparently constituted portions of a dental series not very unlike throughout. Both these groups have a laterally elongated form, with a conical profile, and a prominent central boss or cone, with or without secondary prominences on either side of this. The median teeth of *Cochliodus*, a group which must include several described species of *Helodus*, (e. g. *H. lævissimus*, *H. didymus*, *H. turgidus*, etc.), have been found in regularly diminishing series like some of those now figured. Another group of *Helodi*, of which *H. planus*, Ag., may be taken as a type, in their broad and flattened forms resemble *Psammodus*, to which they approach more nearly than to the turgid and conical species with which they are now associated. These formed a pavement-like dentition which was, perhaps, similar in character throughout the mouth, or they might have formed a part of the varied dental series of *Cochliodus*. It is probable, however, that of these a group may be gathered which would possess a fairly defined generic character. It is desirable, however, for the satisfactory classification of this heterogeneous material, that specimens of at least a considerable number of the species already described should be carefully compared with those now before us, and it is perhaps wiser to wait the time when this shall be possible, rather than to attempt now to make the sub-divisions to which we have referred. It seems to us not probable that *Helodus* should be regarded, as suggested by Prof. McCoy, as a sub-genus of *Psammodus*, or at least that any other than the last group referred to should be so considered. The flat, quadrangular teeth of *Psammodus* form a very natural generic group, and the porosity of their surfaces is no more like that of *Helodus* than *Cochliodus*.

HELODUS CONICULUS, N. and W.

Pl. IV, Figs. 19, 19 *a*.

TEETH small, laterally short, crown composed of a relatively high, rounded central cone, with short lateral appendages; these latter are rounded or obliquely truncated, and project not quite half the diameter of the cone from its base. A sulcus surrounds the crown constricting it, at its junction with the root; root not very short, nearly as broad as the crown, oblique, its vertical face deeply impressed with vermicular cavities; the crown surface is smooth and polished, and uniformly porous throughout.

This species is closely allied to *H. didymus*, Ag., but seems to be distinguished from it by its relatively larger cone, the sulcus around the crown, and the pitted root.

Figures 19, 19 *a*, give a front and side view, natural size.

Formation and locality: Burlington limestone, Burlington, Iowa, and Keokuk limestone, Nauvoo, Illinois.

HELODUS CARBONARIUS, N. and W.

Pl. IV, Figs. 20, 20 *a*.

TEETH small, transversely elongate, crown linear in outline, gently arched laterally, strongly so transversely, smooth and polished throughout, marked with numerous relatively coarse pores, which frequently coalesce, forming a fine but irregular reticulation; root as broad and nearly as high as the crown, very oblique, vertical face, marked with pits and vermicular grooves, inferior surface roughened.

This very distinct species is represented in the collection by a single fragment only. That is, however, sufficient to show its general form and its structure. In form it is not unlike some species we have described, from the lower rocks, but its microscopic structure is unlike that of any other species with which we are familiar. The enamel tubes are much wider than the spaces which divide them, and as they frequently coalesce, they form on the triturating surface a fine reticulation not unlike that of the surface of *Strophodus.*

Figures 20, 20 *a*, represent side view and section, natural size.

Formation and locality: Coal Measures, La Salle, Illinois.

HELODUS DENSHUMANI, N. and W.

Pl. IV, Figs. 21, 21*a*, 21*b*.

TOOTH small but strong, crown sub-quadrate in outline, the angles being rounded, sides slightly arched, margins also rounded, thicker on one side than the other, flattened above, the central portion depressed on the anterior side, leaving an elongated tubercle or prominence on either end, triturating surface highly polished, marked with numerous, large, closely set pores; root quadrangular, as wide as the crown and much higher, coarse and long, sides and posterior face nearly straight; the anterior face showing two concavities separated by a prominent line, the upper much larger; largest diameter of crown 4 lines; shortest 2½ lines; entire height 5 lines.

This peculiar tooth, which, taken by itself, naturally enough falls into the genus *Helodus*, is probably one of the minor forms of some varied dental series. Its robust figure and coarsely porous structure seem to indicate that it was worn by a fish possessing considerable muscular power, perhaps of large size, furnished with a strong crushing apparatus, composed mainly of large and massive teeth, among which this was introduced to fill an interstice, or as one of a medial series. Its form, not unlike that of a worn human bi-cuspid has suggested the name given it.

The figures given represent the crown surface, posterior face and profile, natural size.

Formation and locality: Keokuk limestone, Warsaw, Illinois.

HELODUS BIFORMIS, N. and W.

Pl. IV, Fig. 22, 22 *a*.

TEETH small, in series of three or more, the central one being largest and quite different in form from one of those associated with it. It is oblong in outline, arched in both directions, its highest point being nearly central, its anterior margin somewhat waved with a prominent central gibbosity; the anterior tooth is nearly as large as the central, but narrower, somewhat curved and adapted to the outline of the central one; its surface is raised into three prominences, separated by shallow grooves, of which the central one is somewhat the largest. The small posterior? tooth is about half the size of the central one with a similar median gibbosity. The enameled surface of all these teeth is uniformly punctate, the termini of the enamel tubes being raised above the general surface; the roots are short, narrower than the crown, oblique.

This very distinct and peculiar species exhibits characters considerably different from those of any other with which it is associated in the collection. It is from a geological horizon which has furnished but one other species of *Helodus*, and it may hereafter prove to be a type of a distinct genus. There are contained in the fragments of stone in which it is imbedded numerous small kidney-shaped teeth, having precisely the same structure, and doubtless once belonging to the same fish. We may conjecture that those which we have now described formed a medial series, flanked on either side by broader and flatter teeth, as in the living *Cestracionini*.

Figure 22, the series of three teeth described above, natural size; 22 *a*, a large, detached tooth.

Formation and locality: Kinderhook group, Burlington, Iowa.

HELODUS ELYTRA, N. and W.

Pl. IV, Fig. 23.

TEETH small, in series of three or more of unequal size. Of these the anterior one is most elongated laterally and highest, the middle one shorter, broader and flatter, the posterior one smaller in both senses and flatter than either. They are all oblong in outline, with rounded ends, gently arched both ways, smooth and polished throughout, the surface of each uniformly and relatively coarsely porous. The resemblance which they bear to the elytra of some beetles has suggested the specific name selected.

Figure 23 represents the series described as seen from above, natural size.

Formation and locality: Keokuk limestone, Warsaw, Illinois.

HELODUS COMPRESSUS, N. and W.

Pl. V, Fig. 1.

TEETH small, much compressed, conical in profile, narrow, linear in outline when seen from above; crown thin, compressed, terminating above in a sub-acute edge, having an obliquely conical outline when seen in profile; median cone sub-central, the apex being laterally rounded and somewhat inclined toward one of the extremities; ends rounded, narrowed below to the root; the edge of the crown, between the summit of the cone and the extremity to which it is inclined, faintly notched or waved; anterior and posterior faces of the crown flattened and inclined toward the root; surface highly polished, without pores; root thin, relatively narrow, slightly roughened; breadth 3½ lines, height 2 lines.

This is a very small species, differing in some important characters from any heretofore described. With the general form of *Helodus* it is very much more flattened, having almost a cutting edge. It is apparently composed of dense and homogeneous enamel, without pores. In its compressed crown, its obliquely conical profile it approaches more nearly to the teeth of some living sharks, such as *Galeus*, *Galeocerdo*, etc., than any of the forms with which it is associated.

Figure 1 is a front view, twice the natural size.

Formation and locality: Burlington limestone, Augusta, Iowa.

HELODUS POLITUS, N. and W.

Pl. V, Fig. 2.

TEETH small, laterally elongated, outline linear, expanded at the centre, somewhat curved, profile strongly arched or rudely conical; crown composed of a relatively large central gibbosity, from which slender appendages are given off, forming the lateral extremities; both the central and lateral portions strongly arched transversely, so as to constrict the crown below; entire crown surface covered with dense, homogeneous, black, polished and shining enamel, in which no pores are distinctly visible; root small, oblique, having generally disappeared or remaining only as an ochery mass; length, 7 lines; height of crown, 2 lines.

This peculiar tooth is not likely to be confounded with any which we have described. It will be at once recognized by its singular form and by its highly polished and poreless surface. Specimens of *H. gibberulus*, Ag., now before us, from the Armagh limestone, approach closely to it in form, but in that species is very distinctly, even coarsely porous.

Figure 2 represents the posterior aspect, natural size.

Formation and locality: Keokuk limestone, Nauvoo, Illinois.

HELODUS GIBBOSUS, N. and W.

Pl. V, Figs. 3, 3*a*.

TEETH of medium size; outline as seen from above, linear, with a central protuberance on one side; extremities rounded, profile conical, summit of cone nearest one end, crown strongly arched transversely, and slightly constricted at its base, surface uniformly and finely porous. On one side a conspicuous conical gibbosity protrudes opposite the highest point; base large and thick, as high and wide as the crown, coarse and porous, one face slightly arched outward and striated vertically, the opposite one concave, under surface oblique, smooth. Length, 1 inch; height, 7 lines.

In the character of the root, and the porosity of the crown, this tooth shows some resemblance to *H. denticulatus*, and it is possible they are parts of the same dental series; there are, however, very marked differences in the form of the crown, and, as we have no evidence of identity, we are compelled, for the present, to regard them as distinct.

Figures 3, 3 *a*, represent side view and section, natural size.

Formation and locality: Keokuk limestone, Hamilton and Warsaw, Illinois.

HELODUS PLACENTA, N. and W.

Pl. V, Fig. 4, 4 *a*.

TEETH of medium or small size, sub-elliptical in outline, flattened, thin; crown slightly and irregularly arched in both directions, finely porous throughout, thicker on the posterior than the anterior edge, margin somewhat rounded, root oblique, presenting a vertical face as high as the crown on one side of the tooth, its inferior surface sloping up to the opposite border; the vertical side of the base marked with strong, irregular, vertical ridges.

The tooth is somewhat like *Helodus planus*, Ag , but is less angular in outline, more finely punctate, and wants its characteristic crenulated margin.

Figures 4, 4 *a*, are intended to represent the appearance of one of these teeth, when viewed from above and from the posterior side.

Formation and locality: Kinderhook group, Burlington, Iowa.

HELODUS LIMAX, N. and W.

Pl. V, Fig. 5, 5 *a*, 5 *b*.

TEETH of medium size, laterally elongated, somewhat curved, extremities rounded; entire crown smooth and highly polished, arched laterally, transversely rising into an obtuse and rounded mesial ridge; pores relatively coarse, those of the broader slope elongated, more or less curved, but never inosculating, the root small, half the height of crown, oblique on one side, nearly straight on the other. Length, 11 lines; breadth, 4 lines; height, 4 lines.

The teeth of this species may be recognized by their smooth and rounded outlines without points or angles, by the polished surface, coarse and elongated pores. In their general aspect they bear a striking resemblance to the teeth of *Strophodus tanuis*, Ag., (*Poiss. Foss. Atlas*, *Vol.* 3, *tab.* 18, *fig* 16–25), from the *Oolite* of Stonesfield, though differing from these in microscopic structure. Of described species of *Helodus*, they are most like some forms of *H. lævissimus*, but want any approach to a central cone. The resemblance which they exhibit to the garden slug has suggested their specific name.

Figures 5, 5 *a*, 5 *b*, represent one of these teeth seen from above, the side, and the end, of the size of nature.

Formation and locality: Burlington limestone, Burlington, Iowa.

HELODUS DENTICULATUS, N. and W.

Pl. V, Fig. 6, 6 *a*, 6 *b*.

TEETH of medium size, conical in profile, outline irregular, middle portion broadest, ends rounded sharp, sides scolloped, crown sloping evenly toward either extremity, from the most prominent point, which is not central, strongly arched laterally, bearing along the basal margin of one side numerous, conical, tooth-like prominences, base showing faint traces of enameled folds; triturating surface uniformly, finely, punctate; root as high and broad as the crown, relatively thick, rough and porous, oblique below. Length, 9 lines; height, 5 lines.

The tooth will be readily recognized by the tooth-like appendages set along the sides of the crown.

Figures 6, 6 *a*, 6 *b*, side view, top and profile, natural size.

Formation and locality: Keokuk limestone, Hancock county, Illinois.

HELODUS CRENULATIS, N. and W.

Pl. V, Fig. 7, 7 *a*.

TEETH of medium or large size, outline showing a prominent median angle, the lateral surfaces very unequal in length, somewhat rounded. When seen in profile the outline is also conical, with a prominent angle, but no cone. The crown is arched over transversely, on one side constricted, or the surface turned under; both margins are very neatly crenulated by short, deep, sub-equal sulci; the enameled surface finely and evenly punctate throughout; root very oblique, generally wanting in the fossil state.

This is a laterally short and flattened species, readily distinguishable from any other described by its angled outline, when seen from above, and by the distinct crenulation of the crown margins. The specimens we have described were found mingled with fragments of the teeth of *Cochliodus*, having the same deep black color, and the same microscopic structure. It seems probable therefore, that both once formed parts of the dentition of the same fish.

Figure 7, represents the crown as seen from above, natural size; figure 7 *a*, under side of same specimen.

Formation and locality: Keokuk limestone, Warsaw, Illinois.

HELODUS UNDULATUS, N. and W.

Pl. V, Figs. 8, 8*a*, 8*b*.

TEETH medium size, laterally elongated, somewhat bow-shaped in outline, with a prominence before, a sinus behind; crown conical in outline, the central cone prominent, sub-acute, from this the surface falls off toward either end; upon the lateral portions the enamel is raised into short, broken undulations, and tubercles; the porosity is coarse and somewhat irregular, the root is oblique, coarse and bony, showing a nearly vertical face posteriorly, two-thirds as high as the crown; from the lower margin of this the under surface slopes upward to the crown on the opposite side.

The undulation of the enameled surface constitutes the most distinctive character of the species. It resembles that of a species of *Pœcilodus*, in the collection, and they were perhaps once associated together.

Figures 8, 8 *a*, 8 *b*, represent the view from above and behind, and a profile section, natural size.

Formation and locality: Keokuk limestone, Warsaw, Illinois.

HELODUS ANGULATUS, N. and W.

Pl. V, Figs. 9, 9 *a*, 9 *b*, and 10, 19 *a*.

TEETH elongated, linear in outline, obliquely truncated at the ends, often sigmoidly curved, arched laterally with a mesial ridge, but with no distinct tubercle or cone. In some specimens the triturating surface on either side of the ridge is transversely concave, in others one convex, usually smooth and polished, marked with large, elongated pores; the root is usually oblique, short and wedge-shaped; length, half an inch to an inch; breadth, 4 lines.

These teeth are closely allied to *H. limax*, but the numerous specimens in the collection seem to have a character in common, which that species wants, viz: their angular section. The ends are also generally truncated, not rounded, and they are more twisted. As has been before remarked, this group of teeth are strikingly like some species of *Strophodus*, and it is a suggestive fact that their microscopic structure diverges from that of their congeners in the Carboniferous limestone in the same direction. The pores of the enameled surface forming elongated and irregular lacunæ, approaching in character the angular reticulation of *Strophodus*.

Figures 9, 9 *a*, 9 *b*, represent the top, side views and sections of two of the larger teeth; figures 10–15, smaller specimens, apparently not specifically different.

Formation and locality: Burlington limestone, Quincy, Illinois.

HELODUS SULCATUS, N. and W.

Pl. V, Fig. 16, 16*a*.

TEETH of medium or small size, thin; crown linear in outline, broadest in the middle, the extremities truncated or somewhat rounded; sub-medial obtuse ridge traversing the crown longitudinally, raised in the centre into a more or less prominent gibbosity. The upper side of this ridge is arched over transversely; on the lower side it descends into a broad and deep sulcus, which runs the whole length of the crown, and occupies full half the breadth. The surface of the ridge, and in worn specimens, a part of the sulcus, is finely and uniformly punctate; the lower margin of the crown is usually more or less corrugated or striated vertically, sometimes showing faint traces of marginal plications; root small, oblique, and has usually disappeared.

This species bears considerable resemblance to some of the specimens figured by Agassiz, under the name of *Helodus turgidus*, but is narrower and more distinctly striated. This species is represented in the collection by a large number of specimens, in which the characters enumerated in the above description are quite constant.

Figures 16, 16*a* are top and side views of a specimen, of medium size.

Formation and locality: Keokuk limestone, near Warsaw, Illinois.

GENUS EDESTUS, Leidy.

GEN. CHAR.—Maxillary bone segmented, segments beveled anteriorly and excavated posteriorly for co-adaptation. Teeth in form resembling those of *Carcharodon;* one co-ossified with each maxillary segment.

EDESTUS MINOR, Newb.

Pl. IV, Fig. 24.

TEETH relatively small, 10 lines long, 5½ lines wide at base, 3 lines thick, set saddle-like upon the edge of a flat, bony jaw, conical in outline, acute, margins sharp, coarsely doubly crenulated; sides laterally arched, giving a lenticular section to the tooth; surface smooth and highly polished.

This beautiful and peculiar tooth is evidently similar in its general character to that described by Prof. Leidy (*Jour. Acad. Nat. Sci., Phil., 2d series, Vol.* 3, *p.* 159, *pl.* 15,) under the name of *Edestus vorax*, and to those upon the jaw exhibited before the American Association, at the Providence meeting, August, 1855. Of the latter we have, as yet, no minute description. From the former it differs in its smaller size, double crenulation and angular base. Whether the jaw to which it was attached was segmented, as in *E. vorax*, I am not able to say, as but a small portion of it remains in the specimen before me. It was apparently of dense, bony structure, thin and flat. Of the relations of the fish which bore this tooth little can be said, except that it must have been widely different from any forms now living. The crown of the tooth is remarkably like, both in size, form and crenulation, that of the teeth of *Hemipristis serra*, Agassiz, but the mode of its attachment to the jaw is so different that there could really have been no affinity between them. The teeth of *Hemipristis*, as well as those of *Carcharodon*, have osseous, gibbous bases, which were set upon a cartilaginous jaw, to which they had only ligamentous attachment. In the fossil before us the tooth was firmly cemented to a dense bony jaw. On the other hand, to *Pristis*, with which similar teeth to this one have been compared, it has some slight resemblance, as the teeth of the saw are implanted in a solid bony structure. The fact that they are inserted in cavities is, however, an evidence of a wide difference between *Pristis* and the fossil before us. As Prof. Agassiz remarked, in reference to the jaw exhibited by Prof. Hitchcock —similar to, if not identical with, our fossil—there is reason to believe that this should be regarded not only as a new genus, but a new family of fishes.

Figure 24 represents a side view of this tooth, natural side.

Formation and locality: Coal Measures, Posey county, Indiana.

CHOMATODUS COSTATUS, N. and W.

Pl. V, Fig. 17, 17*a*.

TEETH small, laterally elongated, linear in outline; crown surface linear, flattened, truncated at the extremities, slightly arched on one side, straight on the other, with a prominent carina along the arched margin and another straight one connecting the extremities of the former, like the string to a bow. Along the straight and inferior edge is a ridge marked with elevated spiral lines; the whole surface is smooth and polished, but shows fine pores along the superior costæ. The root is somewhat oblique, narrow, linear, section quadrangular, slightly shorter than the crown.

But a single, though quite perfect specimen represents this species in the collection. It is a handsome, highly ornamented tooth, though its affinities are somewhat obscure. We have referred it, with some doubt, to *Chomatodus*, though it is by no means certain that it will not be hereafter considered generically new.

Figures 17, 17*a* represent the crown face and section, natural size.

Formation and locality: Keokuk limestone, Nauvoo, Illinois.

CHOMATODUS ELEGANS, N. and W.

Pl. V, Figs. 18, 18*a*, 18*b*.

TEETH of large size, laterally elongated; crown linear or long-elliptical in outline, somewhat curved, having a prominent crest running along the medial line, which, near the central point, swells into a rounded tubercle or gibbosity. This mesial crest is on one side arched, on the other side concave, being bordered by a deep and broad furrow, which runs the entire length of the tooth. The surface of this ridge is deeply and regularly pitted by elongated pores or depressions, which have a transverse direction. On either side of the central gibbosity they are larger, giving to the ridge the crenulated and striated appearance of the cutting edge of some species of *Petalodus*. The base of the crown is ornamented by numerous imbricating folds of enamel, those of the posterior descending lower than those on the anterior surface—the former being more numerous and finer; the anterior edge of the base of the crown is also prettily crenulated. The root is in height nearly equal to the crown, its anterior face nearly straight, posterior oblique. Length, 1 inch, 7 lines; breadth, 6 lines; height, 8 lines.

This is one of the handsomest species of the genus. In the specimen before us the medial crest is nearly white, while the pits upon its surface contain, at bottom, black enamel, the basal folds on either side are also jet black. This difference of color, with the variety and beauty of its ornamentation, fully justify us in the choice of the name given it. There is no described species with which it is likely to be confounded.

Figures 18, 18*a*, 18*b*, represent the tooth viewed from behind and above, and a profile section, and are of the natural size.

Formation and locality: Keokuk limestone, Keokuk, Iowa.

HELODUS CONSOLIDATUS, N. and W.

Pl. VI, Figs. 1, 1*a*, 2, 2*a*.

TOOTH compound, consisting of several crowns, firmly consolidated upon a common root; these crowns diverge at different angles from a common centre, and are very unequal in size; anterior and larger one broadly conical in profile, both laterally and transversely, irregularly oblong in outline, ends somewhat rounded; second crown much smaller, conical in profile, with a more or less prominent central gibbosity, oblong-linear in outline, ends rounded; third crown smaller than the second, arched in profile, elliptical in outline, sometimes rudimentary and even wanting. Root nearly as broad as the principal crown, vermicularly rugose above, roughened and bony below, with two marked excavations beneath the larger crowns; posterior margin forming a blunt edge, somewhat rounded laterally. The enameled surface of all the crowns uniformly, somewhat finely punctate, sometimes showing a tubercular rugosity.

There is little doubt that these teeth formed one or more medial series between the broader lateral teeth of *Cochliodus.* With what species of that genus they are associated, it is at present impossible to say; and we are therefore compelled to give it provisionally a distinct specific description and name. From the other compound teeth with which it is associated, in the collection, it may be at once distinguished by its more conical principal crown, its large, bony, solid root, to which its relatively small and distant secondary crowns are firmly anchylosed. There is considerable variation in the length of the root, sometimes but two, perhaps but one crown being attached to it.

Figures 1, 1*a*, 1*b*, represent the superior and inferior surfaces, and side view in outline of an elongated specimen from St. Francisville, Missouri. Figures

2, 2*a*, a broader specimen, with but two crowns, upper and lower surfaces, from Warsaw, Illinois.

Formation and locality: Keokuk limestone, St. Francisville, Missouri, and Warsaw, Illinois.

HELODUS (COCHLIODUS) NOBILIS, N. and W.

Pl. VI, Figs. 3–6.

TEETH forming a series of six, diminishing from before backward, set upon a segment of a circle; the anterior one large and strong, sub-elliptical in outline; the extremities rounded or blunt-pointed. Crown conical in profile, with a sub-median, prominent, ripple-like cone, underneath which is a deep sinus filled by the root; enameled surface, uniformly, rather finely punctate throughout. Root as high and as broad as the crown; anterior face nearly vertical, vermicularly roughened; posterior face higher than anterior, oblique. The smaller teeth of the series are similar in form to the largest, but having the median cone less worn and more pointed.

There can scarcely be a doubt that these teeth occupied the central portion of the jaw, in two or more rows, between the large convoluted teeth which we have described under the name of *Cochliodus nobilis*. This is indicated, and we may almost say proven, by the fact that the specimens figured plate VI, figures 4–6, and plate VII, figures 1, 2, 4, were found impacted together—disarranged, but in contact—and with some traces of the cartilaginous jaw upon which they were once set. The character of the microscopic structure of the crown surfaces is precisely the same in both, as is their color. Whether the entire dental series was procured or whether a portion was lost we have no means, at present, of determining, but the convoluted teeth seem to have been derived from both the upper and lower jaws. There are also many more of the conical ones than the series represented in our figure. Whether these former numerous medial rows were on a single jaw, or were common to both, is as yet undeterminable. As has been before remarked, a want of symmetry of these Helodoid teeth seems to prove that there was more than one row on one, perhaps both of the jaws.

Figures 3, 3*a*, 3*b*, give side and top views and profile section of a large detached tooth. Figures 4, 4*b*, represent one of the series we have described, seen from above and from the side, the latter in profile. Figure 4*a*, the anterior face of the largest tooth. Figures 5, 5*a*, another series, seen from above and in profile. Figure 6, a side view of a series of very small teeth. All from the same locality—natural size.

Formation and locality: Keokuk limestone, near Warsaw, Illinois.

COCHLIODUS NOBILIS, N. and W.

Pl. VII, Figs. 1–4. Pl. VIII, Fig. 1.

The specimens from which our knowledge of this magnificent species is derived, apparently include nearly the entire dental series; they were, however, most unfortunately, collected without sufficient care to preserve every fragment of all the numerous teeth found lying in contact, and no note was taken of their relative positions; had both these particulars been carefully attended to, it is probable we should have been able to make out the complete dentition of *Cochliodus*, and thus throw a flood of light upon the classification of the placoid fishes of the Palæozoic ages. As usually found, the teeth of cartilaginous fishes are severed from their connections, and all traces of the jaws which supported them are lost. In the present exceptional instance, however, the jaws themselves are preserved, and the teeth were in contact, though generally displaced, most of them lying in a confused heap.

Jaws.—Fragments only of the jaws are visible on the specimens contained in the collection, and such as are quite insufficient for determining their form; they are now thin and flattened, and much distorted, showing they had little firmness or rigidity, and were doubtless, for the most part, cartilaginous, though it is possible, in part ossified. They do not show a true bony structure, but exhibit on fracture a fine granular composition, such as we have before seen accompanying the more distinctly bony portions of the remains of cartilaginous fishes, indicating, perhaps, a cartilage through which were disseminated innumerable granules of ossific matter.

The structure of these jaws is very different from that of the bones of the ganoid fishes, which are not unfrequently met with in the Carboniferous rocks. Judging from this evidence and the fact that the teeth of *Cochliodus* are almost universally detached and scattered through the rocks containing them, with no traces of the jaws on which they were once set, we are led to infer that Prof. McCoy was in error in removing *Cochliodus* from the place assigned it by Prof. Agassiz among the sharks, and classing it among the *Pycnodonts*. We may say further, that the specimens before us afford no confirmation of the views suggested by Prof. McCoy, that the succession of teeth was from below upward, as in the *Pycnodonts*, rather than from behind forward, as in the sharks.

Teeth.—The group of teeth here impacted together, includes at least four distinct and different forms, of which the surface markings, microscopic structure, color, etc., are precisely the same throughout. These are, first, large, strongly enrolled teeth, marked with two strong, revolving ridges, separated by a deep furrow (figs. 3 and 4, pl. VII), which correspond to the larger of the two teeth of either ramus of the jaw, figured by Prof. Agassiz, (*Poiss. Foss. Atlas, tab.* 19, *fig.* 14,) constituting the type of the genus *Cochliodus*, and the tooth described by Prof. McCoy under the name of *C. acutus*, Ag., (*Brit. Palæoz. Foss. p.* 621, *pl.* 3 *i*, *figs.* 24, 25). The differences between these teeth and ours being only of a specific character. Our specimens are three times as large as those of Agassiz, the broader ridge terminating in a rounded prominence before reaching the margin; the surface of the tooth strongly wrinkled, etc. These teeth are regarded by McCoy as the posterior pair of the lower jaw. 2d. A narrow tooth equally convoluted, having a wedge-shaped outline when seen from above; perhaps corresponding to the anterior pair in Agassiz's figure. This tooth has a single narrow and low revolving ridge, with numerous obscure plications. 3d. Teeth nearly as long as both the preceding, (figs. 1 and 2, pl. VII), with one broad, rounded, revolving ridge near the oblique extremity, with one or two low and narrow ones near the opposite end, and numerous revolving wrinkles or folds upon the intermediate surface. These teeth are somewhat unlike any heretofore attributed to *Cochliodus*, and probably belonged to the opposite jaw from that which bore those before mentioned; matching into those when in use. If the teeth described by Agassiz and McCoy are, as supposed, from the lower jaw, these are from the upper. 4th. Transversely elongated teeth of smaller size, in diminishing series of six, joined by their longer sides, and in some cases retaining their relative positions. (Pl. VI.) These teeth have more or less distinctly marked prominence or cone upon the crown, and oblique and flattened root often as high as the crown. Considered by themselves they would constitute one or more typical species of the genus *Helodus*. They formed several rows, as is indicated by the differences which they present. In one series taken from this group (fig. 5, 5 *a*, Pl. VI,) the cone of the crown is more or less mammillary in form, sub-central in position, the lateral extremities of the teeth rounded. In another series from the same mass, (Pl. VI, fig. 4, 4 *a*), the cone of the crown is more flattened and very eccentric, the lateral extremities obliquely truncated. A third series consists of six (6) small, elliptical teeth, of which the crowns are arched over without distinct cones. (Fig. 6, Pl. VI.)

The enameled surface of all these teeth, large and small, has a relatively coarse porosity precisely the same in all, and it is impossible to resist the conclusion that they all formed parts of the varied dentition of a single fish. As they are now thrown into a confused heap we can only conjecture what the relative position of each form was. It seems probable, however, that the smaller conical teeth formed several series intermediate between the larger and broader ones, upon the symphysis of the jaw. In the living *Cestracion* we find a precisely similar arrangement. The rami of the jaws are covered with a series of broad, flattened plates, fitted for crushing only, while the mesial portion of each jaw is occupied by numerous rows of small, pointed teeth, diminishing in size from front to rear. The smaller teeth in the group before us would, as has been remarked, if taken by themselves, be referred to *Helodus*, and it is highly probable that a large number of the species of *Helodus* now or heretofore described, were once associated with teeth of very different form, some of which may be known under other names. Several rows of teeth, forming a regular gradation of size, generally similar to those under consideration, have been discovered in the old world, and are described in the works of Agassiz, McCoy, etc. Prof. McCoy, in speaking of a series of this kind, referred to *Helodus lævissimus*, Agassiz, (*Brit. Palæoz., Foss., p.* 631), says, "they diminish in size from behind forward." This seems to us improbable, as upon the supposition that they occupied the mesial space between the larger convoluted teeth, that space would be broadest anteriorly; aside from this we have the analagous arrangement of the teeth in both the *Cestracionts* and *Hybodonts*, as well as in all the living genera of true sharks, in confirmation of the view that the teeth in these rows diminished in size from the front rank backward.

Formation and locality: Keokuk limestone, Warsaw and Nauvoo, Illinois.

COCHLIODUS? CRASSUS, N. and W.

Pl. VIII, Figs. 2, 2*a*.

TEETH thick, massive, sub-quadrate in outline, the two longer sides respectively convex and concave, one of the lateral angles of the concave side being prolonged, the superior surface is strongly arched from the front backward with a lateral sulcus extending to the produced posterior angle; it is highly polished, marked with faint waved lines of growth parallel with the convex anterior margin, and a few obscure wrinkles crossing these. The central portion of the tooth is evenly punctate; near the margin the enamel tubes being concealed by an exterior coating, as is frequently the case with teeth of this and allied genera when but slightly worn. Antero-posterior diameter to extremity of prolonged angle, 1 inch, 8 lines; transverse diameter 1 inch, [illegible] lines; height 11 lines.

This [illegible] is not distinctly referable to any known genus, though coming nearer to [illegible] than any other. Awaiting the discovery of other specimens which will throw more light upon its affinities, we place it provisionally in [illegible], associated as it was in the rocks from which it was obtained, with the large species of *Sandalodus*, described by us under the name of [illegible], which it resembles in its massive strength and surface markings, we have thought it possible that it might have been a portion of the same dental series with these. This is, however, mere conjecture, which will be confirmed or disproved by future observation.

Figures [illegible], represent the upper surface and profile, natural size.

[illegible] limestone, Warsaw, Illinois.

Genus ANTLIODUS, N. and W.

Gen. Char.—Teeth flattened, more or less arched on both directions, variable in size and outline, sub-rhomboidal, oblong or [illegible], the larger pair in each series having a trapezoidal outline, and being obliquely rolled, scroll-like, over the [illegible]. The superior surface is smooth or nearly so, uniformly [illegible] punctate throughout, the edges more or less [illegible]; the inferior surface smooth or slightly roughened, corresponding to the jaw surface on which it rested. The [illegible] are irregularly rounded or polygonic in outline, [illegible] in both directions, resembling in form some [illegible].

We [illegible] under the above generic title a group of teeth quite [illegible] in the collection, which seem to form a connecting link [illegible], a portion of them having the twisted or [illegible] others more nearly plain, [illegible] in form and functions. They all want, however, [illegible] the teeth of [illegible], and differ [illegible] in the crenulated edges. They [illegible] system of pavement-like dentition, which [illegible] distinctness.

Judging from the figures and descriptions before us, it seems to us probable that *Cochliodus magnus*, Ag., and *Helodus planus*, Ag., should be separated from their present generic connections and included in *Aspidodus*. *Cochliodus magnus*, Ag., corresponds closely in form with some of the teeth now figured, and it certainly wants the characteristic revolving ridges and convoluted form of that genus. It has been suggested by Capt. Jones (Potlock's Geol. Report, p. 642), that *Helodus planus* is but a form of *Cochliodus magnus*.

ASPIDODUS CRENULATUS, N. and W.

Pl. VIII, Figs. 3–11.

TEETH small, flattened thin, showing considerable variety of form and size; being mostly trapezoidal with five unequal sides, one or more of the sides being sometimes rounded, a portion of the series showing a deep notch on one of the sides. Teeth forming several pairs, which occupied corresponding positions on the opposite sides of the mouth. Of these pairs, among the largest and the thickest is one which is obliquely rolled or twisted—as in *Cochliodus*—is narrow, trapezoidal in outline, with one angle much produced. This was probably the terminal tooth on each side, homologous with the largest tooth in *Cochliodus*. The upper surface of all the teeth is covered with a thick coating of nearly smooth, uniformly pitted enamel. The articulating edges are strongly crenulated, the inferior surface nearly smooth.

The convoluted pair of this series of teeth bear a marked resemblance to those described by Agassiz, under the name of *Cochliodus magnus*, and there can be no reasonable doubt that they are generically identical, and yet, being longer, narrower and more revolute, they must be considered specifically distinct.

It is, perhaps, not quite certain that all the varied forms which we now include in *A. crenulatus* should be so united, but the principal pair were evidently articulated with others of different form from their own and all the series now figured have as indications of identity the common locality, pentagonal outline peculiarly similar surface and microscopic structure.

Figures 3–11, represent 12 of these teeth, of natural size; figures 3, 3 *a*, the most convoluted pair.

Formation and locality: Chester limestone, Chester, Illinois.

ASPIDODUS CONVOLUTUS, N. and W.

Pl. VIII, Figs. 12, 12*a*.

TEETH robust, ovoid in outline as seen from above, thick and massive, strongly revolute, having a cylindroid figure; upper surface without revolving ridges or furrows, finely striated transversely, uniformly filled throughout; under surface nearly smooth.

This singular tooth scarcely corresponds to any other in the collection or heretofore described. In the generalities of its form and structure it approaches most nearly to the revolute forms of *A. crenulatus*, and as it is derived from the same locality, we have thought best to place it provisionally in the same genus with that species. The only specimen contained in the collection is considerably broken, so that its entire figure can not be determined from it. It is, however, so conspicuous, from its size and form, that it seems desirable that it should be published in order that it may be of use for geological purposes.

Figures 12, 12*a*, respectively, represent the upper surface and profile section, natural size.

Formation and locality: Chester limestone, Chester, Illinois.

PŒCILODUS RUGOSUS, N. and W.

Pl. VIII, Fig. 13.

TOOTH oblong or sub-elliptical in outline, posterior extremity sub-acute, anterior truncated, strongly revolute, with two prominent revolving ridges, separated by a deep central furrow; crown surface highly ornamented with numerous sub-equal folds of enamel, running nearly parallel with the basal margin. Where unworn these are angular carinæ, with one broad and one narrow, almost perpendicular, sides; upon worn surfaces they form rounded, transverse ridges, which undulate its outline. The enamel pores are uniformly distributed over the entire surface. Length, 1 inch, 6 lines; breadth, 8 lines; enameled folds, half a line in breadth.

This tooth is generally similar in form and markings to *Pœcilodus Jonesii*, Ag., but is much larger, and the furrow between the two prominences is central, while in *P. Jonesii* it is nearest the anterior end. *P. obliquus*, McCoy, is also much smaller and the ridges are angular.

Figure 13 represents a posterior upper? tooth, seen from above—natural size.

Formation and locality: Keokuk limestone, Warsaw, Illinois.

PŒCILODUS ORNATUS, N. and W.

Pl. VIII, Fig. 14.

TEETH flattened, slightly arched, very thin, sub-triangular or trapezoidal in form, the posterior extremity pointed, basal margin sinuous, lateral margins nearly straight; crown surface raised into a low, rounded, sub-central ridge, running nearly parallel with the posterior margin; from this the surface slopes down gradually to the anterior end on the other side, descending into a broad, shallow furrow, which extends to the posterior border. It is everywhere ornamented with prominent raised lines, nearly parallel with each other and the basal margin, about 3 to every 2 lines in width. The summits of these carinæ are crenulated, and their slopes transversely striated by a kind of vermicular rugosity. Where the ridges are most widely separated, the unworn enamel is finely tubercular; where worn, it is dotted by the sections of these tubecles. Length, 1 inch, 6 lines; breadth of imperfect specimen, 1 inch.

While generally similar to the other species of the group, which includes *P. rugosus*, Nob., *P. obliquus*, McCoy, *P. Jonesii*, Agassiz, etc., it differs from all these in its thin and flattened form, and in the complex character of its ornamentation.

Figure 14 represents posterior terminal tooth, natural size.

Formation and locality: Keokuk limestone, Warsaw, Illinois.

GENUS DELTODUS, N. and W.

GEN. CHAR.—Teeth of medium or large size, thick and strong, triangular in outline, more or less arched, sometimes enrolled in the line extending from the longest and most acute angle to the opposite margin; crown-surface sometimes simply arched, more generally marked by 1–3 prominent ridges, running from the basal margin toward the longest angle. In some species the triturating surface is also undulated by a series of transverse obtuse ridges, parallel with the basal margin, and mostly confined to the basal portion of the tooth. The crown-surface is uniformly punctate, the size and form of the pores varying on the different species.

This genus is created to receive a group of teeth, largely represented in the collection before us, and of which some species have been described heretofore in Europe, under the names of *Cochliodus* and *Pœcilodus*. It is evident, however, that they should be separated from *Cochliodus*, as they are more triangular in form and generally much less curved; and it will be seen, by a comparison with *Pœcilodus*, that while the forms of some species approach that of *Pœcilodus*, they are distinguished from that genus by the character of the surface. In all the true *Pœcilodi* the enameled surface is corrugated by distinct transverse ridges, which occupy all the crown face from base to summit of the teeth, and give them a peculiarly ornamented appearance. [See plate VIII, figs. 13 and 14.] In two foreign species of *Pœcilodus* (*P. augustus* and *P. marginatis*) the transverse rugæ are unbroken undulations and so different from those in the species cited as to render it doubtful whether they should be included in the same generic group. One species of *Deltodus* now described and figured (*D. undulatus*, plate IX, fig. 5,) is also undulated, but not in a manner and to a degree inconsistent with its association with the smoother species with which we have classed it. Another species, however (*D. cingulatus*, figure 6), presents some characters which doubtless will be considered to have generic value, and we only refrain from separating it from *Deltodus*, at the present time, from an unwillingness to make a single and imperfect tooth the basis of a generic description. In that tooth the crown surface is composed of alternate transverse bands of enamel and dentine, these bands being of nearly equal width and running quite across the tooth, and extending from base to summit.

It is almost certain that the triangular teeth which we have referred to the genus *Deltodus* were but a portion of the dentition of the fishes which wore them, as they are undoubtedly the homalogues of the larger teeth of *Cochliodus;* but we can not, as yet, determine the character, number or position of those with which they were associated.

DELTODUS ANGULARIS, N. and W.

Pl. IX, Fig. 1.

POSTERIOR teeth of small size, triangular in outline, thick; crown surface marked with a sharp, narrow, oblique keel, which runs from the prominent posterior summit. This is bordered by a broad and deep sub-central furrow, from which the surface runs into a broad, flattened ridge, which borders the straight side; entire enamel surface finely punctate. Antero-posterior diameter, 1 inch.

Figure 1 represents a posterior tooth seen from above, natural size.

Formation and locality: Coal Measures, La Salle, Illinois.

DELTODUS STELLATUS, N. and W.

Pl. IX, Figs. 2, 3, 3 *a*.

POSTERIOR tooth spirally revolute, obliquely triangular in outline, both angles of the broader extremity somewhat rounded, a sharp, prominent keel runs from the larger basal angle to the pointed summit. From this ridge the surface descends abruptly to the nearest margin, more gradually into a well defined sulcus, which runs along the opposite border; enameled coating is marked with a few faint lines of growth, parallel with the broader margin, and obscure longitudinal grooves or wrinkles, is uniformly porous throughout, the pores being relatively large, angular in outline, many of them stellate; length 1 inch, 9 lines; breadth 1 inch, 1 line.

The posterior teeth of this species will be readily recognized by their narrow triangular form, remote transverse lines of growth, the angular keel, the longitudinal plication, and particularly by their coarse, angular, sometimes stellate porosity.

The anterior teeth are strongly revolute, transversely arched, the base rounded and expanded into a ring-like angle on one side, where there is a broad, shallow, marginal furrow or depression. The surface markings are similar to those of the posterior teeth, except that the longitudinal ridges are less conspicuous, sometimes being wholly obsolete; the porosity is coarse, more or less angular and irregular, rarely stellate.

Figure 2, represents the superior surface of a posterior tooth; figures 3, 3 *a*, an anterior ? tooth; both natural size.

Formation and locality: Keokuk limestone, Warsaw, Illinois.

DELTODUS COMPLANATUS, N. and W.

Pl. IX, Fig. 4.

TEETH broadly triangular in outline, narrower end terminating in an acute point, the border extremity having one obtuse angle, the other broadly rounded, slightly arched spirally, but as compared with the associated species flat and thin. A low, obtuse ridge passes from the angle of the broader extremity to the pointed end; from this ridge the surface declines rapidly on one side, very gradually on the other, to the lateral margins; a faint rudimentary ridge being sometimes visible midway of the broader surface, with the higher one converging to the acute extremity; enameled surface smooth and polished, every where finely punctate.

Figure 4 represents the superior surface in profile, natural size.

Formation and locality: Burlington limestone, Henderson county, Illinois.

DELTODUS UNDULATUS, N. and W.

Pl. IX, Fig. 5.

POSTERIOR tooth strongly arched, triangular in outline, its broader extremity somewhat emarginate, one of the angles broadly rounded, the other sub-acute; a prominent rounded ridge passes from the rounded angle of the broader end to the acute extremity, bordered by a deep sulcus, which, starting from the emargination of the broader end, converges to the same point; enameled surface highly polished and shining, undulated by broad, transverse, elevated bands separated by narrower sulci, which give an undulated outline to the lateral margins, and to the profile; punctation of the upper surface strongly marked throughout. Length, 2 inches; greatest breadth, 1 inch, 3 lines.

This beautiful species may be at once recognized by its highly polished and shining surface, and its broad, transverse undulation. *Pœcilodus sublævis*, McCoy, is somewhat like it, but is smaller, less strongly marked by the transverse ridges and sulci, and with a less deep longitudinal furrow.

Figure 5, represents the upper surface, natural size.

Formation and locality: Keokuk limestone, Keokuk, Iowa.

DELTODUS CINGULATUS, N. and W.

Pl. IX, Fig. 6.

TEETH narrow, wedge-shaped in outline, spirally enrolled, the broader end obliquely rounded; triturating surface transversely arched, marked with numerous conspicuous, obliquely transverse, sub-equal ridges or belts of enamel, separated by parallel furrows of nearly equal width; the surface of the furrows is coarsely porous and reticulated, that of the ridges very finely and evenly punctate.

In this species we have an extreme instance of the division of the triturating surface into bands of unequal hardness, which constitute the distinctive character of *Pœcilodus*. Here the surface is divided into broad, transverse, zone-like bands, more than a line in width; alternations of hard, dense, smooth enamel, and coarse, reticulated bone. The bands of harder material are most prominent, and give to the profile an undulated outline. This interesting tooth will, doubtless, be ultimately separated from *Deltodus* and placed in a genus created to receive it and its more immediate congeners. Without more material, however, we refrain from attempting to define the characters and limits of such a genus.

Figure 6, represents the crown surface, natural size.

Formation and locality: Chester limestone, Chester, Illinois.

DELTODUS SPATULATUS, N. and W.

Pl. IX, Fig. 7.

ANTERIOR? tooth obliquely spatulate in outline, spirally curved, long and narrow; the broader end obliquely rounded, sides converging to a simple point above, relatively thick; crown surface strongly arched in both directions, without distinct keels or furrows, uniformly granulo-punctate throughout.

The narrow, crenate form, and simple surface, will enable one to distinguish this species from those with which it is associated.

In some of the specimens the base is somewhat broader, and the basal angle common to most species of the genus begins to show itself, while there is a slight depression of the crown along the margin of that side, the representative of the usual furrow. The outline is narrower, however, and more spatulate, and the whole tooth more simple, than in any other species with which we are acquainted. The punctation of the surface is relatively coarse, and there are raised rings about the orifices of the enameled tubes. Length, 1 inch, 8 lines; greatest breadth, 10 lines.

Figure 7, represents a large and narrow specimen, natural size.

Formation and locality: Burlington limestone, Quincy, Illinois.

DELTODUS RHOMBOIDEUS, N. and W.

Pl. IX, Fig. 8.

POSTERIOR tooth arched, scarcely revolute, sub-rhomboidal in outline, the broader end irregularly rounded, the narrower end obliquely truncated; the upper surface marked with two nearly parallel, low, obtuse, longitudinal ridges, of which one is marginal, the other central; the latter being bordered on one side by a shallow furrow separating it from the stronger marginal ridge, on the other by a broader and deeper groove, which occupies the lateral interval between it and the more oblique margins. One or more lines of growth are discernible running parallel with the outline of the broader end; these produce little inequality of surface, but are marked by bands of color. The triturating surface is evenly granulo-punctate, except along the margins of the narrower end, which are vermicularly roughened.

This species is distinguished from the others, now or heretofore described, by its more oblong or rhomboidal outline, the lateral margins not converging to a common point; the more oblique one forming another angle before reaching the pointed extremity. The ridges of the surface are also parallel, whereas in most other species they converge. Length, 1 inch, 10 lines; breadth at base, 1 inch.

Figure 8, represents the superior surface seen from above, natural size.

Formation and locality: St. Louis Limestone, St. Louis, Missouri.

DELTODUS GRANDIS, N. Sp.

Pl. IX, Fig. 9, 9*a*.

TEETH of large size, thick and strong, triangular in outline, spirally convoluted. An obtuse, angular ridge runs from the obtuse angle of the broader extremity to the narrower end, from which the surface falls off laterally into a deep sulcus, which converges toward the same point; the acute angle of the broader end is strongly elevated. The enameled surface is highly polished and smooth, except where showing a few faint lines of growth parallel with the broader margin. It is uniformly punctate throughout, and where most worn the orifices of the enamel tubes form simple pits in a smooth surface; where it has suffered less abrasion it is minutely shagreened by elevated rings about their orifices.

The specimen before us affords an interesting illustration of the severity of the duty performed by these teeth when in use, a piece having been broken out of its most prominent part during the life of its possessor; the edges of the fracture being rounded by subsequent wear, its bottom and sides being coated with a new deposit of enamel.

Figures 9 and 9*a*, represent the upper surface and profile, natural size.

Formation and locality: Keokuk limestone, Warsaw, Illinois.

GENUS SANDALODUS, N. and W.

GEN. CHAR.—Teeth of medium or large size, thick and strong, sub-triangular or club-shaped in outline, with one and sometimes two pointed extremities; generally somewhat twisted, slightly arched longitudinally, strongly so transversely; enameled surface firmly and uniformly punctate; base deeply concave both ways, curves following those of the surface of the crown; toward the narrower end, in some species, one or two obtuse ridges running obliquely over the tooth, as in *Cochliodus*.

In many respects these teeth show a resemblance to those of *Deltodus* and *Cochliodus*, but differ from them in their narrower, straighter forms and in wanting, as a general rule, the ridges and furrows which are such conspicuous characters in these genera. It is probable that with these elongated triangular teeth there were associated others of different form, as we know was the case in all or nearly all of the allied genera. If so, they are doubtless represented among the many hundreds of placoid teeth which have been taken from the beds where these were found. Whether any such exist in the collection, we can, of course, only conjecture, as the cartilaginous supports upon which they once rested have entirely decomposed, and the teeth, separated from their connections, scattered broadcast over the sea bottom. The tooth which we have called *Cochliodus? crassus*, (plate VIII, figs. 2 and 2*a*,) with a form quite unlike any heretofore described, has the same dense and massive structure and precisely similar surface with the larger species of *Sandalodus* (*S. grandis*), which is also found in the same stratum, at the same locality—near Warsaw. It is therefore at least possible that this beautiful specimen is one of the short intermediate teeth of that genus.

SANDALODUS PARVULUS, N. and W.

Pl. X, Fig. 1.

TEETH small, thin, irregularly oblong in outline, obliquely truncated at the narrower end, broader extremity pointed, triturating surface slightly arched longitudinally, strongly so transversely, finely and uniformly punctate throughout, under surface strongly concave, smooth.

This minute species is represented in the collection by a single, though perfect tooth. In its very small size and the oblique truncation of the narrower end, it differs from the species that have been described, though similar to them in general form.

Figures 1 and 1*a* represent the top and side views, natural size.

Formation and locality: St. Louis limestone, Alton, Illinois.

SANDALODUS SPATULATUS, N. and W.

Pl. X, Fig. 2.

TEETH of medium size, broader extremity regularly rounded, the other narrow, long-pointed, acute, slightly arched longitudinally, strongly and regularly so transversely; enameled surface coarsely and evenly punctate, and showing several curved parallel furrows or lines of growth; length, 1 inch, 9 lines; breadth; 7 lines; thickness, 3 lines.

This species may be distinguished, at a glance, from its associates, by its size, its coarsely punctate, rugose and furrowed surface, and by its having one end broadly and evenly rounded, while the other is drawn out into a long, acute point.

Figure 1 is a view of the upper surface.

Formation and locality: St. Louis limestone, Hardin county, Illinois.

SANDALODUS ANGUSTUS, N. and W.

Pl. X, Fig. 3.

TEETH small, very narrow, linear in outline, strongly arched laterally, much more strongly so transversely; the crown surface rising into a distinctly marked longitudinal ridge; surface smooth, or roughened by the uniform and rather coarse punctation.

But a single specimen of this tooth is contained in the collection, and that may prove to be but a fragment of a larger and differently formed one.

Figure 3 represents the upper surface, natural size.

Formation and locality: Keokuk limestone, Warsaw, Illinois.

SANDALODUS CARBONARIUS, N. and W.

Pl. X, Fig. 4–5.

TEETH sub-spatulate, one side being straight, the other regularly rounded, broader end rounded to the straight margin, the opposite extremity prolonged, narrowed, upper surface gently arched longitudinally, laterally more strongly, highest point of the arch forming an obtuse ridge nearer the straight than the rounded margin; all the enamel coating very finely and evenly punctate.

All of the specimens included in the collection are imperfect, the narrower end being broken. It is therefore impossible, as yet, to determine with accuracy the entire outline. We have therefore placed them in the genus *Sanda lodus*, with some doubt, although, so far as shown, their characters ally them more closely to the preceding species of *Sandalodus* than to any other fossil teeth heretofore described. The general form seems to have been sub-spatulate, considerably like that of *S. spatulatus*, though probably having the narrower end less pointed. This portion of the tooth is much the thinnest, and has, therefore, been liable to mutilation. The triturating surface is very finely and beautifully pitted, the pits being deeper, more regularly spaced and more closely set than in any of the teeth which have come under our observation.

Figures 4 and 5 represent two specimens from the same locality. They differ in size, though similar in form, except that one is dextral, the other sinistral.

Formation and locality: Coal Measures, LaSalle, Illinois.

SANDALODUS LÆVISSIMUS, N. and W.

Pl. X, Figs. 6, 7, 8.

TEETH of large size, sub-triangular in outline, terminating in long and narrow pointed extremities, strongly arched in both directions. Near the narrow end two faintly defined ridges are discernable, rising from the longest margin and running obliquely toward the centre of the tooth; entire upper surface smooth and highly polished, but under the lens shown to be very finely and uniformly punctate.

This species bears a strong resemblance to *S. grandis*, but is more elongated in form and is entirely without the wrinkles and folds that conspicuously mark that species, a character which is regarded of even generic value (though, as we think, unwarrantably,) among the similar forms of *Cochliodus* and *Deltodus*.

Figures 6, 7 and 8 represent dextral and sinistral specimens, or those from opposite jaws, of the natural size.

Formation and locality: Keokuk limestone, Warsaw, Illinois.

SANDALODUS GRANDIS, N. and W.

Pl. X, Fig. 9.

TEETH large, thick and massive; 5 inches long, 1 inch, 8 lines wide at broadest part, 9 lines thick; broader end somewhat rounded, with an obtuse lateral angle; narrower extremity produced into a moderately long, obtuse point, from which a distinct, though not prominent ridge runs along the line of the axis of the tooth to about its middle. Crown surface strongly arched, both transversely and longitudinally, near the broader end, roughened by lines of growth and fine longitudinal wrinkles; elsewhere smooth and highly polished, finely and uniformly punctate.

The specimens from which the preceding description was taken, may be only old and fully grown teeth of *S. lævissimus*, but they are more rounded at the broader end, more strongly arched and show numerous distinct wrinkles and lines of growth, while in *S. lævissimus* the entire crown surface is smooth and highly polished. As has been before suggested, the massive sub-quadrate tooth which we have named provisionally *Cochliodus? crassus*, coming from the same beds and showing a similar surface, may possibly have belonged to the same fish with the teeth under consideration.

Figure 9 is taken from a specimen in the collection, which is complete with the exception of the angular terminus of the broader extremity. The strongly marked longitudinal ridge shown in the figure is in part due to the wear to which the tooth was subjected while in the jaw, and consequently somewhat exaggerates that character.

Formation and locality: Keokuk limestone, Warsaw, Illinois.

GENUS RINODUS, N. and W.

GEN. CHAR.—Teeth of medium or large size, elongated in form, with an expanded, sub-conical base, and a flattened or furrowed crown; enamel tubes arranged in transverse rows, producing on the triturating surface a series of transverse furrows and ridges which give it a file-like roughness.

In form and microscopic structure these teeth depart so widely from all known living or fossil types that at present we are scarcely able to offer even a conjecture in reference to their affinities. They would seem to have been formed rather for grinding than crushing, and in the alternation of bands of harder and softer material in the enameled coating of the crown, we have the adaptation of means to an end, as clearly shown as in the grinders of the Elephant, which indeed seem to be foreshadowed in this the dentition of a Devonian fish.

RINODUS CALCEOLUS, N. and W.

Pl. X, Figs. 10, 10*a*, 10 *b*, 10 *c*.

TEETH laterally compressed, forming an unequal and irregular frustrum of a cone; the summit truncated, compressed and deeply furrowed longitudinally; base more or less excavated beneath. The general form is very much that of a low shoe, a resemblance which has suggested the specific name given to it. The sides of the tooth are marked with a series of more or less interrupted and inosculating, horizontal, raised lines and furrows, of nearly equal breadth. The summit is occupied by a plate of dense enamel marked like the sides, but across this the lines run transversely, giving it a file-like surface. In the specimens before us this enameled crown is hollowed into a broad, longitudinal sulcus; when examined under a powerful glass, the roughening of the triturating surface is seen to be affected by the arrangement of the enameled tubes, which are placed in rows side by side, forming sulci which are separated by ridges of harder material. The base is deeply excavated longitudinally, and the under surface shows the same peculiar structure as the upper; length 2 inches; greatest breadth 8 lines.

Figures 10, 10 *a*, 10 *b*, are top and side view and profile section, natural size; figure 10 *c*, magnified view of the crown surface.

Formation and locality: Hamilton group, Calhoun county, Illinois.

GENUS PSAMMODUS, Ag.

GEN. CHAR.—"Teeth oblong, wide, thick, flat above, without cones or keels; surface porous or minutely rugose; base of the same form as the crown, very thick, coarse, osseous."

PSAMMODUS POROSUS, Ag.?

Pl. XI, Figs. 1, 1 *a*, 1 *b*.

TEETH oblong or nearly square, the angles of one end being right angles, of the other, one acute and one obtuse; triturating surface more or less concave, in the line of its largest diameter; slightly arched transversely; in perfect specimens smooth and polished, every where dotted with fine and nearly equal pores marking the termini of the calcigerous tubes; thickness one half to one fourth of length; base of the same form as the crown, coarse and cellular.

The specimens in the collection which we have referred to this species, are undistinguishable, by any well marked characters, from those described by Prof. Agassiz. (*Poiss. Foss. Vol.* 3, *p.* 112, *Atlas*, *Vol.* 3, *tab.* 13).

Figures 1, 1 *a*, 1 *b*, give the top, side and end views, natural size.

Formation and locality: Chester limestone, Chester, Illinois.

PSAMMODUS ANGULARIS, N. and W.

Pl. XI, Fig. 2, 2 *a*, 2 *b*.

TEETH small, thin, oblong, or trapezoidal in figure; surface of crown plain or slightly curved, generally smooth except as roughened by the uniform and relatively coarse punctation; base relatively thin, of the same form as the crown, but somewhat smaller; sides forming remarkably sharp angles with the crown.

This is a thin and small species, more exact and angular in form than any other hitherto described. The crown is bordered throughout nearly its entire outline by a salient, acute angle, which it forms with the relatively smooth sides; this angle is made more prominent by a narrow and shallow sulcus. The base is very thin, giving to the tooth a less relative thickness than in any other species known. (see fig. 2*b*.) The pores of the surface are relatively large, but circular, distinct and never confluent, as in *P. rugosus.*

Figure 2, 2 *a*, 2 *b*, represent the top, side and profile, natural size.

Formation and locality: Chester limestone, Chester, Illinois.

PSAMMODUS RUGOSUS, Ag.

Pl. XI, Fig. 3, 3 *a*.

TEETH oblong or quadrate in form; surface of crown plain, slightly arched or concave, according to the place of the tooth in the mouth; uniformly roughened by relatively large and deep pores, which are frequently confluent, giving it a rugose character; base, coarse and osseous, of the same form as the crown.

The specimens in the collection which we have supposed might represent this species, are too imperfect for satisfactory determination. They are, however, readily distinguishable from the finely punctate teeth, we have referred with doubt to *P. porosus*, the surface being coarser and rougher, as in *P. rugosus.* This difference, taken in connection with the fact that they are derived from formations which have almost no other fossils in common, has led us to regard them as distinct.

Prof. McCoy regards both of Agassiz's species as mere varieties, and it is quite possible they are so, but in the teeth before us, the differences of microscopic structure are so marked and radical, that conclusive evidence must be required before they will be regarded as specifically identical.

Figures 3 and 3 *a*, are top and side views, natural size.

Formation and locality: St. Louis limestone, Alton, Illinois.

PSAMMODUS? SEMI-CYLINDRICUS, N. and W.

Pl. XI, Fig. 4, 4*a*.

TEETH thick and strong, sub-semi-cylindrical in form, oblong in outline, twice as long as wide; crown strongly arched transversely, to a less degree longitudinally; enameled surface occupying all the higher portions of the tooth; where unworn, granular and shagreen-like; where worn, regularly porous; around the margin the rugosity partaking of the vermicular character of the surface of the base; base transversely concave, thinning laterally into sharp and irregular margins.

In its form this species somewhat resembles *Ps. canaliculatus*, McCay, (*Brit. Pal., Foss.*, *p.* 643, *pl.* 3*g*, *fig.* 12,) but is at once distinguishable from it by the absence of the plications and gibbosity of the crown, which form the marked characters of that species.

The shagreen-like rugosity of the triturating surface, to which allusion has been made in the above specific description, is not peculiar to this tooth, but is common to several species of this and allied genera. It is only shown where the enamel coating is unworn, and disappears upon the exposed portions of long used teeth. It is due to the presence of raised rings about the extremities of the enameled tubes, and is doubtless a provision of nature to prevent the slipping of the teeth over the smooth surfaces of shells or other hard substances which it was their function to crush. In worn teeth the roughness which they retain is due to the pores or pits formed by the sections of the enameled tubes.

Figures 4, 4*a*, represent one of these teeth as seen from above and in profile.

Formation and locality: Keokuk limestone, Warsaw, Illinois.

PSAMMODUS RETICULATUS, N. and W.

Pl. XI, Figs. 5, 5*a*.

TEETH oblong, more or less flattened, thin; crown irregularly arched transversely, nearly straight longitudinally, slightly depressed at the ends, showing a few remote transverse sulci; rugosity of triturating surface nearly uniform, coarse, reticulated by the intersection of short, tortuous lines and furrows, running parallel with the longest diameter of the tooth.

The only specimen, representing this species in the collection, is somewhat mutilated, but still exhibits well marked characters by which it may be readily recognized wherever found. The rugosity of the surface is much like that of *Ps. rugosus*, Ag., and it also resembles that species in its transverse wrinkles or furrows; but, unless a portion only of the original thickness of the tooth is represented in the specimen before us, it must have been far thinner and lighter than any form of *P. rugosus* which has been described.

Figures 5, 6 *a*, represent the upper surface and a transverse section of the tooth, of the size of nature.

Formation and locality: Chester limestone, Monroe county, Illinois.

PSAMMODUS? RHOMBOIDEUS, N. and W.

Pl. XI, Figs. 6, 6 *a*.

TEETH rhomboidal in outline, thick, strongly arched in both directions; triturating surface, sub-rhomboidal, with rounded angles, forming a prominent disc or boss, surrounded by the roughed and irregular base. On two sides the crown is somewhat compressed, inclosing a prominent angle or ridge which rises to the summit of the tooth. Other portions of the triturating surface are arched in both directions. The base on two sides is much depressed, on the third less so, and on the fourth somewhat turned up. It is rough and porous; in the central portion of the tooth, thick, but thinning toward the edges, which are irregular. The base is below deeply excavated, strongly concave in the line of its shortest diameter, nearly straight in its longest. Most of the triturating surface is uniformly punctate, the pores in the center being relatively small and remote. Near the margin they are larger and more confluent, ultimately merging into the vermicular roughening of the base.

This tooth is considerably unlike those hitherto described, and as yet little can be said in regard to its relations with them, or those with which it is associated, in the locality where it is found. We have placed it provisionally in the genus *Psammodus* because it seems most to resemble some of the varied forms which still remain included in that genus. It is by no means certain, however, that it has any closer affinity with the typical species of *Psammodus* than with *Cochliodus*, *Helodus*, and perhaps other genera of the cestraciont family. Doubtless, in time, material will be obtained which will permit future palæontologists to determine its affinities with more accuracy than can be done at present. In the hope of hastening that time the figures and descriptions of it are now given. We have some reason to believe, however, that we have, in this and other teeth, from the same vicinity and geological level, representatives of one or more genera, distinct from any hitherto designated by special names, teeth which hold an intermediate place between *Psammodus* and *Cochliodus*. These are in addition to that under consideration, and such as should probably be referred to the same species, those we have designated by the names of *Psammodus semi-reticulatus*, *Trigonodas minor*, *T. major*, several species of *Sandalodus*, etc. Of these, some, at least, depart very widely from the tile-like teeth of the typical species of *Psammodus*, and no one would think of including them in the same generic group. Others, however, such as that under consideration, show perhaps sufficient relationship in their microscopic structure, and in their broad, more or less tubular forms, to the true *Psammodi*, to be appropriately classed with them until such time as the dentition of the fishes to which they belong shall be more fully made out.

Figure 6, crown surface, from above; 6*a*, side view, natural size.

Formation and locality: Keokuk limestone, Warsaw, Illinois.

GENUS TRIGONODUS, N. and W.

GEN. CHAR.—Teeth thick and strong, sub-triangular in outline, strongly arched in both directions, with a central boss or prominence, from which one or more ridges descend to the angles or to the larger side; triturating surface uniformly and finely punctate; inferior surface deeply concave.

This genus is established to receive a number of teeth constituting two species included in the collection, which, with the microscopic structure of *Cochliodus*, seem by their peculiarities of form to be essentially distinct from that genus. They formed strong, crushing implements, doubtless serving the same purposes with those of the large group of Cestraciont genera, with which they are associated in the Carboniferous limestone. In their forms they show a marked departure from the more common types of Cestraciont teeth, and approach more nearly to that of some portions of the triturating apparatus of the Chimæroid fishes. But we should be unwarranted in inferring, upon such slight evidence, the existence of Chimæroid sharks at the period of the deposition of the Carboniferous limestone.

TRIGONODUS MAJOR, N. and W.

Pl. XI, Figs. 8, 9, 9 *a*.

TEETH sub-triangular, with one longer and two shorter sides, the latter including the best defined angle, near which is the most prominent portion of the tooth, the shortest sides are subequal somewhat curved, longer side more or less waved, and irregular. The central prominence forms a broad arched surface from which two obtuse ridges descend, the longer one to one of the angles, the shorter one to the long and irregular margin. From the central prominence the surface falls off toward the opposite angle in a broad, shallow furrow; enameled surface highly polished and finely punctate throughout; length, 1 inch, 9 lines; greatest breadth, 1 inch; height, 7 lines; thickness at centre, 4½ lines.

Figures 8 and 9, represent a pair of teeth apparently from the opposite sides of the same jaw; figure 9 *a*, the profile from the angled side, natural size.

Formation and locality: Burlington limestone, Quincy, Illinois.

TRIGONODUS MINOR, N. and W.

Pl. XI, Figs. 7, 7 *a*.

TEETH half the size of *T. major*, sub-triangular in outline, shorter sides curved, longer nearly straight. Of the small angles one is rounded, the other sub-acute; the most prominent point of the crown, half way between the obtuse and the rounded angle, being the summit of the arched ridge which connects them. Towards the acute lateral angle the surface slopes down uniformly with no distinct sulcus. The surface rising from the margin which connects the medial with the rounded lateral angle marked with 4 or 5 sub-equal and parallel ridges, which arch over from the medial toward the rounded angle; enamel surface finely and evenly punctate; length 1 inch, 3 lines; greatest breadth 7 lines.

This species may be distinguished from the preceding by its smaller size, by its most elevated point being nearer to one of the lateral angles, by the absence of the ridge running down to the longer side, and by the plication of one of its faces.

Figure 7 and 7*a*, represent the crown as seen from above, and the profile from the side of the medial angle.

Formation and locality: Keokuk limestone, Nauvoo, Illinois.

GENUS HOMACANTHUS, Ag.

GEN. CHAR.—Fin-spine small, rather rapidly tapering, moderately arched backwards; sides flattened, converging to the anterior face, which is obtusely keeled; sides covered with few very coarse, longitudinal ridges, and fine striæ in the same direction; posterior margin with two rows of denticles arched downwards.

This genus differs from *Leptacanthus* and *Ctenacanthus* in its small size, and the sides being covered with very few, strong, nearly smooth ridges. The genus is by no means a well defined one, but when confined to the two following species, and the Russian Devonian one, already published, it has a sufficiently distinct facies.

HOMACANTHUS GIBBOSUS, N. and W.

Pl. XII, Fig. 1.

SPINE small, slender, strongly arched backward, narrow and compressed throughout the upper two-thirds of its length, then rapidly expanding toward the base till at the point, when the ornamentation ceases, it is nearly twice as broad as in the middle; immersed base without ornament, somewhat roughened, and irregularly conical about one-fifth of the entire length; exposed portion marked throughout with longitudinal, tubercular carinæ, separated by surfaces which are striated; anterior margin acutely carinated, and set with a row of small tubercles distant from each other about the width of the spine at its middle point; lateral surfaces occupied above by 3, below by 5 or 6, longitudinal carinæ, each tuberculated in the same manner as the anterior edge, but the tubercles somewhat more closely set; the spaces between the carinæ flat, and marked with wavy, longitudinal striæ; posterior border sulcated, and each side of the sulcus set with closely approximated teeth. At, and above the middle of the spine, these denticles are very small, conical, contiguous, and scarcely depressed; toward the base they become much larger, more remote and strongly hooked downward. Entire length, 2 inches, 2 lines; breadth at base, 1½ lines; at base of ornamental part, 3 lines; immersed base, 4 lines.

This species may be readily distinguished from the succeeding one by its strongly arched form, its swollen base, and posterior denticles very small and numerous above, larger and sparser below, while in *H. ? rectus* they are largest near the summit. From the species of *Homacanthus* described by Agassiz and McCoy, it is clearly distinct specifically, and perhaps generically. The genus *Homacanthus* was established by Agassiz upon some very small spines from the Devonian rocks of Europe. In their general aspect these spines show a marked resemblance to our *H. gibbosus* and *H. rectus*, but in the details of their structure they are so unlike, it is doubtful if they should be classed together. In the typical species of *Homacanthus* (*H. arcuatus*, Ag.), the spine has nearly the form, though about half the size, of *H. ? gibbosus;* the base relatively broad and irregular, the exposed posterior fluted longitudinally, bearing numerous, small, depressed denticles on the posterior border. No detailed description of these spines is given by Prof. Agassiz, and his figures are our only guides in making the comparison of these two, represent spines with smooth, longitudinal costæ. In the third they seem to be interruptedly tubercled or pectinated. In the general character given by McCoy the costæ are said to be few, strong and nearly smooth. In both the species now described the ridges are distinctly tubercled. In each of the three species of *Homacanthus*, hitherto described, the denticles of the posterior border are nearly uniform in size, and are strongly hooked downward; while in the spines under consideration the denticles are very unequal in size, and unlike in form, the larger ones only being distinctly depressed. These characters would seem to be sufficiently marked to justify us in considering them as distinct from *Homacanthus*, and as types of a new genus. From the smaller amount of material, however, now in our hands, we have refrained from adding another to the already long list of ill-defined genera of fossil fishes, and have placed them provisionally in *Homacanthus*.

Figure 1, side view, natural size.

Formation and locality: St. Louis Limestone, St. Louis, Missouri.

HOMACANTHUS? RECTUS, N. and W.

Pl. XII, Fig. 6.

SPINE small, slender, straight, or very slightly arched, compressed, with an elliptical section; immersed portion about one-sixth of the entire length, narrowed, compressed laterally, having a triangular section, rapidly drawn to a rude point below; exposed portion marked by 6–7 rounded longitudinal costæ on either side, which are set with remote rounded tubercles, arranged in lines descending obliquely from the anterior border, and being separated three times as far longitudinally as laterally in the middle of the spine. The spaces between the costæ are of less than equal breadth with them, and are obscurely striated longitudinally. The only specimen in the collection does not fully give the form and arrangement of the denticles of the posterior border, those of the upper portion alone being visible. These are, however, of unequal size and relatively very large, being nearly as long as the diameter of the spine where they are set.

In the great size of some of the denticles this species resembles *H. macrodus*, McCoy, (*Op. cit.*, *p.* 632, *pl.* 3 *K*, *fig.* 20,) but that species is much more curved, broader, and has fewer longitudinal costæ.

Figure 6, side view, natural size.

Formation and locality: St. Louis limestone, St. Louis, Missouri.

GENUS LEPTACANTHUS, Ag.

GEN. CHAR.—Fin-spine very long, narrow, gently arched backwards, very gradually tapering, greatly compressed, sides flattened; anterior face thin, keeled; surface covered with very numerous, longitudinal ridges and striæ; posterior side set with two rows of numerous, close, small, downward-curved denticles.

LEPTACANTHUS? OCCIDENTALIS, N. and W.

Pl. XII, Fig. 2.

SPINE long, slender, gently arched backward, very much compressed throughout, sides flat; anterior edge sharp, posterior edge conspicuously furrowed and bordered by two rows of small, acute, compressed and depressed hooks, of which the bases are nearly in contact; lateral surfaces occupied by numerous subequal, parallel, continuous, smooth, flattened costæ, near the base about 15 on either side, at the middle 9–10, and near the summit 4–5, the number being increased below by the bifurcation of those occupying the upper part of the spine. The specimens before us are neither of them complete, but they indicate a total length of about 6 inches, with a breadth at base of about 6 lines, the average thickness being one-fourth the breadth.

We have referred these spines to *Leptacanthus* with much doubt, as there seems to be little probability that they are generically identical with those from the *Oolite*, which Agassiz first designated by that name. It is true the general form is similar, but the striated or obscure and confusedly costate surface of the typical *Leptacanthi* must have given them an aspect widely different from that of these spines, so uniformly and regularly ribbed throughout. The suspicion that these differences are generic is also strengthened by the fact that up to the present time no teeth have been found, both in the Lower Carboniferous and Jurassic rocks, which have been referred to the same genus; and it is scarcely probably that while the fin-rays of these ancient placoids have been met with in considerable numbers, that the much more numerous teeth could have been overlooked. We infer, however, from the figures and descriptions of Prof. McCoy, (*British Palæozoic Fossils, p.* 633, *pl.* 3 *G*, *figs.* 13, 14 and 16,) that the species which he calls *Leptacanthus junceus* and *L. Jenkinsoni* are generically identical with ours; the latter species being distinguishable from that before us only by the less perfect regularity of costation near the base, greater spacing of the denticles, and the striations of the surface—fair specific differences. If, then, Prof. McCoy's carboniferous fin-spines are properly referred to *Leptacanthus*, ours should be so; but for the reasons given above it seems in some degree probable that the reference of his specimens to that genus was unwarranted. The resemblance which the spines before us and those of Prof. McCoy bear to some of the more slender and compressed forms, now included in *Ctenacanthus*, such as *Ct. distans*, McCoy, and *C. gracillimus*, Nob., is very marked and is suggestive of closer relationship than has been assigned them. These species of *Ctenacanthus* have been associated with the great hybodoid spines, *Ct. major*, Agassiz, *C. hybodoides*, Egerton, etc., simply on account of their sharing with them the inconstant and unequally exhibted character of the tuberculation or pectination of the longitudinal costæ. As we have before remarked, this is almost too variable and superficial a character to serve as a band of generic union between organs of which the facies are so diverse. We would, therefore, suggest to those who, hereafter in the possession of more ample material, may be better able to adjust the classification of these fossil fishes, the question whether the long, slender and flattened species of *Ctenacanthus*, cited above, should not be united with *Leptacanthus junceus*, *L. Jenkinsoni*, and the present species, in a generic group, distinct from both *Ctenacanthus* and *Leptacanthus*.

Formation and locality: St. Louis limestone, St. Louis, Missouri.

GENUS ORACANTHUS, N. and W.

ORACANTHUS PNIGEUS, N. and W.

Pl. XII, Fig. 3.

SPINE conical, short and robust, as broad at the base as high, anterior margin nearly straight, posterior outline much curved, anterior surface covered with relatively large stellated tubercles, irregularly scattered toward the base, on the upper half arranged in short oblique lines, extending from the anterior border to the middle; posterior surface occupied by smaller tubercles, without regular arrangement.

The mass of this spine was originally cartilaginous, covered with a thin, bony, ornamented crust, which formed a solid bony tip at the summit. In the fossil the cartilage having disappeared, the external shell has been crushed in and its opposite internal surfaces brought in contact. Hence, as found, the spine is flat, and except at the solid apex, has a thickness of scarcely more than two lines. This is a well marked species of the genus, resembling more *O. abbreviatus*, Newb., from the Devonian limestone of Ohio, than any other described. From this it differs, however, in its less oblique base, in its distinctly stellate tubercles, and their partial linear arrangement. In *O. abbreviatus* the tubercles are smooth, or nearly so, and are irregularly disseminated over the surface. Length of posterior margin, 1 inch, 3 lines; of anterior border, 2 inches; base, 1 inch, 6 lines.

Formation and locality: Keokuk limestone, Keokuk, Iowa.

GENUS CTENACANTHUS, Ag.

GEN. CHAR.—Fin-spine of moderate and large size, compressed, gradually tapering, moderately arched backwards; anterior face narrow, rounded; posterior face concave, with a moderate cavity, the lateral edges bordered by two rows of curved denticles, inclined downwards; surface marked with strong, longitudinal ridges and furrows, pectinated by transverse scales or tubercles. The concealed base of moderate size, rapidly tapering, finely striated.

CTENACANTHUS ANGULATUS, N. and W.

Pl. XII, Fig. 4, 4*a*.

SPINE small, robust, compressed, posterior outline nearly straight; anterior border arched backward; posterior margin flattened or slightly hollowed, half the breadth of the lateral surfaces; anterior margin rounded below, acute above, section a triangle having sides twice as long as the base; anterior half of the surface of the spine (more below, less above the middle) occupied by distinct, parallel, continuous carinæ, those on and near the anterior border pectinated by very numerous transverse edges, which on the posterior carinæ become small, distinct, rounded tubercles; posterior half of the lateral surfaces marked with fine, and interrupted longitudinal striæ; posterior surface finely striated longitudinally; striæ reticulated; posterior angles set with numerous, small, depressed hooks, separated by about the width of their bases.

This is a peculiarly exact and elegant little spine, of which the surface is every where highly ornamented. Its most striking character is perhaps its angularity, but the ornamentation is peculiar, and such as will readily serve to distinguish it from any species hitherto described. The anterior surface is occupied by relatively large and distinct costæ, strongly pectinated, as is common in the genus, while about half of the lateral surfaces, and all the posterior sulci, are marked by fine, longitudinal, interrupted, or reticulated striæ. Near the base the greater part of the lateral surface is covered by the pectinated or tuberculated ridges, while toward the summit the striæ encroach upon the costæ, and occupy most of the side. The only specimen in the collection, though apparently representing nearly the entire length of the spine, wants the extreme summit, and that part of the base which was buried in the teguments of the back. It is 3½ inches long, by 6 lines wide. The lateral parietes of the central cavity near the base were evidently quite thin, and have been crushed in by pressure from without.

It will be noticed that both this and the preceding species referred to the genus *Ctenacanthus* are all small and delicate in form and markings, contrasting strongly with many species of the genus which have been described, especially with the large, nearly cylindrical spines, described by Agassiz and Egerton under the names of *C. major*, *C. hybodoïdes* and *C. nodosus*, and we may justly doubt whether the long, slender, and delicate spines such as *C. distans*, McCoy, and *C. gracillimus*, Nob., were borne by fishes generically identical with those which carried the formidable weapons named above. While, however, we have only the spines with which to classify these ancient placoids, and the differences which they present are rather of degree than kind, we must be content to group together those which are generally similar, waiting the time when the spines and teeth can be found together, and their generic relations more accurately established.

Figures 4, 4 *a*, side and posterior faces, natural size.

Formation and locality: Chester limestone, Chester, Illinois.

CTENACANTHUS? COSTATUS, N. and W.

Pl. XII, Fig. 5.

SPINE short, robust, slightly arched backward, with an ovate section near the base, elliptical above; basal portion once sunk in the integuments about one fourth of the total length, irregularly pointed, smooth or finely striated; exposed portion coated with polished enamel, strongly ribbed longitudinally; anterior border occupied by a single broad and smooth carina, three times the width of the costæ of the sides; lateral surfaces occupied at base by broad parallel longitudinal ribs separated by much narrower sulci. The external surface of these ribs is smooth and polished, but their sides are set with closely approximated tubercles which give them an elegant beaded appearance and nearly fill the sulci.

In the only specimen included in the collection a portion of the posterior surface of the spine is wanting. The number and form of the denticles which once existed there can not, therefore, be fully determined. Above this part are a few tubercles which seem to have formed a double row along the posterior surface of the lower portion of the spine. The ribs are of nearly equal breadth and are continuous throughout, except the two anterior ones, which become obsolete before reaching the summit.

Until better specimens can be obtained, or such as show the posterior denticles more distinctly, a full and satisfactory description can scarcely be made out. It is evident, however, that the specimen before us represents a strongly marked and hitherto undiscribed species, which will be at once recognized by its few, strong, longitudinal costæ, plain and smooth in their outer faces, elegantly beaded along their sides.

Formation and locality: St. Louis limestone, St. Louis, Missouri.

GENUS DREPANACANTHUS, N. and W.

GEN. CHAR.—Fin-spines of medium or large size, more or less compressed laterally, gradually tapering to an acute point, strongly curved, point turned forward; anterior margin set with a single row of large, flattened or conical tubercles; lateral surfaces set with numerous small tubercles, arranged in longitudinal and sometimes transverse rows; posterior margin rounded or flattened, without hooks, sometimes carrying one or more rows of relatively large tubercles.

These spines, with our present imperfect knowledge of them, seem to present some anomalous characters of special interest, as they separate them somewhat widely from most of the defensive spines of living placoid fishes, the study of which has thrown so much light on those found fossil. Of these exceptional characters, the most remarkable is their reversed curve. Nearly all of the dorsal defensive fin-rays hitherto known, of living or fossil sharks, are straight or more or less curved backward, the point being turned toward the caudal extremity. They are also planted obliquely in the integuments in such a manner that the point is thrown backward even where they are straight, the posterior margin of the exposed and ornamented portion being shorter than the anterior. Such is the position of the spines of *Spinax*, *Cestracion*, etc., of recent fishes, and was the position of those of *Hybodus*, *Ctenacanthus*, and most other extinct genera, as is proved by the line of contact with the dorsal surface, sloping upward from the convex to the concave border. This is also generally indicated by the curvature, the position of the medullary cavity (nearer the posterior margin), the greater dégree of ornamentation along the anterior, the presence of hooks upon the usually sulcated posterior edge or face, etc. In *Drepanacanthus*, on the contrary, we find the line of contact with the dorsal surface generally plainly marked; sloping upward at an angle of 45° from the concave to the convex margin; the medullary cavity nearest the convex edge, and opening first there; the concave margin most highly ornamented, etc., etc. All of which characters seem to indicate that while the base was inserted in its normal condition, projecting forward and downwards into the integuments of the back, the exposed portion was curved forward instead of backward. It is true that if the position of the base was reversed, projecting downward and backward instead of forward, the spine being thrown entirely in advance of the base, we should then have, with the normal curvature of the exposed portion, the line of demarcation between the ornamented summit and the plain base, as we now find it, slanting upward from the concave to the convex border. It may not, therefore, be now possible to determine with absolute certainty in which of the two ways these spines were worn. The place and form of the medullary cavity, however, and the ornamentation, seem to indicate, as before stated, that while the base held its normal position the summit was curved forward. This structure would require no change in the muscular attachments of the base, by which the spine was elevated and depressed, while any other supposition would require very important modifications of the ordinary apparatus by which their movements were effected.

In their surface markings the spines under consideration resemble those of *Oracanthus*, and it is probable one or more species have been described under that name that more properly belong with those on which the genus *Drepanacanthus* is now proposed; but the typical species of *Oracanthus*, such as *O. milleri*, Agassiz, *O. vetustus*, Leidy, *O. pnigeus*, Nob., were more broadly conical in form and were composed of a cartilaginous center, covered with a thin crust of bone and enamel, which was solid only at the tip; and we have no evidence that any of the spines of this character were curved forward at the apex or were toothed along the posterior border. In *Drepanacanthus*, on the contrary, the spine was composed of dense, fibrous, bony tissue, with a pulp cavity of moderate size, and the surface was not all covered with an enamel coating, but thickly studded with spheroidal tubercles of black, glass-like enamel, and was strongly curved forward at the summit.

The figure and description of *Oracanthus pustulosus*, (*Agass. Poiss. Foss.*, *Vol.* 3, *p.* 15, *Atlas*, *Vol.* 3, *Tab.* 2, *figs.* 3 *and* 4,) although representing only a fragment, indicate a spine very different in its aspect and structure from *O. milleri*, and the other species enumerated above, and one much more like those which we have designated by the name of *Drepanacanthus*. So little of *O. pustulosus* is preserved that it is not easy to decide whether, like these, it was heterostrophe or not; but the greater relative thickness of bone on what was regarded as the *posterior* side of the cavity, and the crowding of the tubercles over the exterior surface of the same region, might lead us to suspect that the convex side was the posterior, and that it was heterostrope. The tubercles of *O. pustulosus* are not fully described by M. Agassiz, but, judging from the figure, they are spheroidal in form and ornamented by sharp carinations, just as are those of a species *Drepanacanthus* now before us. If so, they are strikingly different from those of the typical species of *Oracanthus*, which are conical, with a more or less acute summit and a broad base, from which often radiate many radicles of enamel. These reach up on to the sides of the cones, and give them the stellate appearance which they usually, though not constantly, present.

If other and more complete specimens of *O. pustulosus* should confirm the conjectures we now make in reference to its curvature and ornamentation, it would be a well-marked, and even typical species of the genus *Drepanacanthus*.

DREPANACANTHUS ANCEPS, N. and W.

Pl. XII, Fig. 8.

SPINE small, much curved and compressed throughout its entire length; section lenticular, with acute edges; width near base 6 lines, thickness 1 line; concave margin acute, and set with a line of relatively large tubercles; convex border acutely carinated, without tubercles but finely striated longitudinally; lateral surfaces bearing numerous small, round, smooth tubercles, near the concave border, densely crowded and without linear arrangement, toward the convex border, especially below, they are also numerous, though less crowded than along the opposite edge, their nearest margin forming about three longitudinal lines. Those more remote are smaller and are dispersed in short, transverse lines. The median half of the lateral surface bears only a few minute tubercles, and like all the other portions of the surface between the tubercles is finely striated longitudinally. The position, size and form of the pulp cavity is scarcely determinable from the only specimen before us. It is apparently situated, however, nearest the convex border. The ornamentation of the surface descends much lower on the concave than on the convex border; the line limiting the ornamentation—the line of junction with the surface of the back—rising from the concave toward the convex border at an angle of about 45°.

The resemblance of this spine to some species of *Oracanthus*, both in general form and ornamentation, is so strong that, were it not for the fact that the line of junction with the dorsal surface was inclined upward from the concave edge, we should scarcely dare separate it from them.

Formation and locality: Coal Measures, Springfield, Illinois.

DREPANACANTHUS GEMMATUS, N. and W.

Pl. XIII, Fig. 1.

SPINE large and strong, 10 to 12 inches in length, one in width at base, gradually narrowed to the apex, which is strongly curved forward, much compressed throughout, section near the base a long ellipse, truncated anteriorly, nearer the summit the sides are flat and parallel, the anterior border rounded, posterior margin occupied by a broad and shallow sulcus, bounded by prominent salient angles without denticles and divided in the centre by a low but distinct continuous carina; anterior margin rounded and set along the median line with a row of round flattened tubercles about a line in diameter, and separated by intervals of equal or slightly greater breadth. On either side of this larger row of tubercles is a second of about half their size below, of nearly equal size above, behind these are, on either side, 20 to 25 longitudinal parallel rows of similar, but smaller, tubercles, which progressively diminish in size to the posterior or convex border, and are very uniformly distributed over all of the lateral surfaces. These tubercles are accurately arranged in longitudinal rows, most of which are continuous from base to summit. They also exhibit an imperfect transverse alignment. Those of the anterior median line are flattened and smooth, as though somewhat worn, but the others generally, and these partially, are beautifully ornamented by numerous, sharp, converging carinæ, which rise from the base, and, when not obliterated, cover the entire surface. They are stringent on the upper side of the tubercles, the interval between the tubercles seems to have been smooth bone without enamel, the tubercles having the appearance of globules of brilliant black glass, and look as though they had exuded through pores in the bone, and had congealed on the surface, studding it with gems. Under the lens these ornamented globules are exceedingly pretty, and have suggested the specific now given. On some of them the raised lines have a spiral arrangement giving them the appearance of seeds of the *Chara*.

That part of the spine which was enveloped in the integuments partakes of the general curve of the exposed portion, its sides are flattened and smooth, and converge to form a sub-acute edge in front, on which is a tubercular excresence as large as half a pea, just below the first of the enameled tubercles. The posterior border of the basal portion is deeply sulcated to its extreme point by the continuation of the pulp cavity, which was apparently open posteriorly from the point where the ornamentation ceases. The margins of this sulcus are thin and sharp, and are usually more or less broken. The smooth and flattened surfaces of the base seem to indicate some kind of an articulation, and it is perhaps possible that bony or cartilaginous guides were applied on either side, between which the spines were firmly held during their elevation or depression. This would give an accuracy of movement and a firmness scarcely inferior to that afforded by the gingylmus articulation of the dorsal spines of the *Siluroids.*

Figure 1, represents the side view of a spine broken at either end; 1 *a*, transverse section; 1 *b*, an enlarged tubercle of the anterior border; 2, a nearly perfect base of another specimen.

Formation and locality: Keokuk limestone, Keokuk, Iowa.

DREPANACANTHUS? STELLATUS, N. and W.

Pl. XII, Fig. 7.

SPINE small, strongly curved forward, with an elliptical section above, oval below; convex margin rounded and ornamented with three rows of relatively large, longitudinally remote, compressed stellate tubercles; concave margin rounded and set with a single row of large, conical, pointed, stellate tubercles, largest toward the base of the spine; lateral surfaces regularly arched, with numerous longitudinal rows of small, conical or laterally compressed tubercles, most distinct on the anterior border, separated longitudinally by intervals of twice their diameters, laterally closely approximate, forming oblique, transverse lines. In the middle of the spine there are about fifteen longitudinal rows of small tubercles on either side, more below, fewer above. The large tubercles of the convex (posterior?) border are separated longitudinally by spaces of twice their longest diameters. Transversely they are in apposition, forming short transverse lines of three tubercles each.

We have included this spine in *Drepanacanthus* with some hesitation, as the imperfection of the only specimen in the collection is such as to leave several important points in its structure in doubt If, as we have supposed, the curve of the summit was forward, as in *L. gemmatus*, it would naturally fall into the same genus with that spine; for although the tubercles of the concave border are much higher and more tooth-like, and the flattened and keeled convex border of *L. gemmatus* is here wholly wanting, still the style of ornamentation is so similar that, with the striking character of a strong reversed curve in common, it would be difficult to find good cause for their separation.

Unfortunately the specimen before us wants the base, without which the question of its curvature can only be conjecturally decided. The facts which have led us to suspect that the curve of the tip was forward are: 1st. On the concave side of the spine the bony wall of the central cavity is much thicker than on the convex side, on which the pulp cavity runs out some distance above the base. 2d. The tuberculation of the lateral surfaces become stronger toward the concave border, fading out toward the convex. The natural inference from these facts is, that the curve of the spine was reversed, as in most others; the posterior wall is thinner than the anterior, and is broken through above the base; the tuberculation of the lateral surfaces is, in most or all allied spines, strongest on or near the anterior border. These indications are not wholly conclusive, however, and may be fallacious. If so, this would constitute the type of a new genus, as, though allied to *Oracanthus*, *Asteracanthus* and *Myriacanthus*, perhaps in an equal degree, it could be united with neither of them. From the first it is distinguished by its more slender form and the denticles of the concave border. According pretty well with *Asteracanthus* in general form (if not reversely curved) and in its stellate tubercles, it is separated from that genus by the diversity in size, form and arrangement of its tubercles, and its geological position. With *Myriacanthus* it agrees in the variety of its ornamentation, but not in its form nor geological place. Other specimens will be required. before its relations can be fully determined.

Formation and locality: Keokuk limestone, Warsaw, Illinois.

CTENOCANTHUS GRACILLIMUS, N. and W.

Pl. XIII, Fig. 3.

SPINE very long and slender, (9–12 inches long, 4–5 lines wide) gently arched, much compressed, scarcely more than a line in thickness with a lenticular section; anterior margin acute, posterior edge truncated below, above sulcated longitudinally, and set with two rows of acute, compressed, strongly depressed hooks, of which the bases are contiguous; each side is ornamented with, about 10 below, 15 above, nearly equal continuous, parallel, somewhat flattened, longitudinal carinæ;

which are near the summit all smooth. The anterior medial carina throughout the entire length of the spine, and toward the base 3–4 of the anterior lateral carinæ ornamented with numerous, obliquely transverse, prominent rings; those of the lateral carinæ passing into tubercles and becoming obsolete upward.

This is a remarkably slender, as well as beautiful, spine; the ornamentation being exceedingly neat and sharply defined. It is evidently closely allied to *C. distans*, McCoy, from the Mountain limestone of Armagh, Ireland, which is nearly as slender, and in its general aspect must be very similar. From the description and figure of *C. distans*, given by Prof. McCoy, (*Brit. Palæozoic Fossils*, *p.* 625, *pl.* 3 *K*, *fig.* 15), I infer, however, that there are well marked differences between the American and European fossil, which will readily serve to distinguish them. In *C. distans* the form is somewhat more robust and more curved, the teeth of the posterior margin less numerous and less depressed, and the lateral longitudinal carinæ, instead of being as in our fossil nearly all smooth, are all crenulated by transverse rings or tubercles.

From the other species of *Ctenacanthus*, described by McCoy, Agassiz and others, that before us is so widely separated that no comparison with them is necessary.

Formation and locality: St. Louis limestone, St. Louis, Missouri.

SYNOPTICAL TABLE

OF VERTEBRATES DESCRIBED IN THE FOREGOING PAGES.

Class PISCES.

ORDER GANOIDEA.

Family LEPIDOIDEA.

GENUS PALÆONISCUS.

P. peltigerus, N. and W. Coal Measures.

Family CŒLACANTHI.

GENUS RHIZODUS.

R. occidentalis, N. and W. Coal Measures.

ORDER PLACOIDA.

Family HYBODONTIDÆ.

GENUS CLADODUS.

C. robustus, N. and W. Sub-carboniferous.
C. micropus, N. and W. Sub-carboniferous.
C. spinosus, N. and W. Sub-carboniferous.

C. stenopus, N. and W. Sub-carboniferous.
C. mortifer, N. and W. Coal Measures.
C. magnificus, Tuomey. Sub-carboniferous.
C. angulatus, N. and W. Sub-carboniferous.
C. zygopus, N. and W. Sub-carboniferous.
C. ferox, N. and W. Sub-carboniferous.
C. politus, N. and W. Sub-carboniferous.
C. costatus, N. and W. Sub-carboniferous.
C. turritus, N. and W. Sub-carboniferous.
C. grandis. N. and W. Sub-carboniferous.
C. lamnoides, N. and W. Sub-carboniferous.
C. gracilis, N. and W. Coal Measures.

Genus DIPLODUS.

D. latus, Newb. Coal Measures.
D. compressus, Newb. Coal Measures.
D. incurvus, N. and W. Sub-carboniferous.
D. duplicatus, N. and W. Sub-carboniferous.

Genus CARCHAROPSIS.

C. Wortheni, Newb. Sub-carboniferous.

Family PETALODONTIDÆ.

Genus PETALODUS, Owen.

P. destructor, N. and W. Coal Measures.
P. linguifer, N. and W. Sub-carboniferous.

Genus PETALORYNCHUS, Ag.

P. striatus, N. and W. Sub-carboniferous.

GENUS CTENOPTYCHIUS, Ag.

Ct. semicircularis, N. and W. Coal Measures.

GENUS ANTLIODUS, N. and W.

A. robustus, N. and W. Sub-carboniferous.
A. mucronatus, N. and W. Sub-carboniferous.
A. parvulus, N. and W. Sub-carboniferous.
A. similis, N. and W. Sub-carboniferous.
A. cucullus, N. and W. Sub-carboniferous.
A. politus, N. and W. Sub-carboniferous.
A. minutus, N. and W. Sub-carboniferous.
A. simplex, N. and W. Sub-carboniferous.
A. sulcatus, N. and W. Sub-carboniferous.

GENUS DACTYLODUS, N. and W.

D. princeps, N. and W., (type). Sub-carboniferous.
D. lobatus, N. and W. Sub-carboniferous.
D. inflexus, N. and W. Sub-carboniferous.

GENUS POLYRHIZODUS, McCoy.

P. porosus, N. and W. Sub-carboniferous.
P. dentatus, N. and W. Sub-carboniferous.
P. ponticulus, N. and W. Sub-carboniferous.

GENUS CHOMATODUS, Ag.

Ch. gracillimus, N. and W. Sub-carboniferous.
Ch. cultellus, N. and W. Sub-carboniferous.
Ch. pusillus, N. and W. Sub-carboniferous.
Ch. affinis, N. and W. Sub-carboniferous.

Ch. angularis, N. and W. Coal Measures.
Ch. molaris, N. and W. Sub-carboniferous.
Ch. multiplicatus, N. and W. Sub-carboniferous.
Ch. costatus, N. and W. Sub-carboniferous.
Ch. elegans, N. and W. Sub-carboniferous.
Ch. loriformus, N. and W. Sub-carboniferous.

Family CESTRACIONTIDÆ.

GENUS ORODUS, Ag.

O. multicarinatus, N. and W. Sub-carboniferous.
O. plicatus, N. and W. Sub-carboniferous.
O. elegantulus, N. and W. Sub-carboniferous.
O. ornatus, N. and W. Sub-carboniferous.
O. tuberculatus, N. and W. Sub-carboniferous.
O. mammilaris, N. and W. Sub-carboniferous.
O. minusculus, N. and W. Sub-carboniferous.
O. minutus, N. and W. Sub-carboniferous.

GENUS HELODUS, Ag.

H. biformis, N. and W. Sub-carboniferous.
H. elytra, N. and W. Sub-carboniferous.
H. coniculus, N. and W. Sub-carboniferous.
H. compressus, N. and W. Sub-carboniferous.
H. carbonarius, N. and W. Coal Measures.
H. sulcatus, N. and W. Sub-carboniferous.
H. crenulatus, N. and W. Sub-carboniferous.
H. denticulatus, N. and W. Sub-carboniferous.
H. nobilis, N. and W. Sub-carboniferous.
H. consolidatus, N. and W. Sub-carboniferous.
H. politus, N. and W. Sub-carboniferous.
H. undulatus, N. and W. Sub-carboniferous.
H. limax, N. and W. Sub-carboniferous.

H. denshumani, N. and W. Sub-carboniferous.
H. angulatus, N. and W. Sub-carboniferous.
H. gibbosus, N. and W. Sub-carboniferous.
H. placenta, N. and W. Sub-carboniferous.

GENUS COCHLIODUS, Ag.

C. nobilis, N. and W. Sub-carboniferous.
C. crassus, N. and W. Sub-carboniferous.

GENUS ASPIDODUS, N. and W.

A. crenulatus, N. and W. Sub-carboniferous.
A. convolutus, N. and W. Sub-carboniferous.

GENUS SANDALADUS, N. and W.

S. lævissimus, N. and W. Sub-carboniferous.
S. carbonarius, N. and W. Coal Measures.
S. spatulatus, N. and W. Sub-carboniferous.
S. grandis, N. and W. Sub-carboniferous.
S. parvulus, N. and W. Sub-carboniferous.
S. angustus, N. and W. Sub-carboniferous.

GENUS PSAMMODUS, Ag.

P. porosus, Ag. Sub-carboniferous.
P. angularis, N. and W. Sub-carboniferous.
P. rugosus, Ag. Sub-carboniferous.
P. semicylindricus, N. and W. Sub-carboniferous.
P. rhomboideus, N. and W. Sub-carboniferous.
P. reticulatus, N. and W. Sub-carboniferous.

GENUS TRIGONODUS, N. and W.

T. major, N. and W. Sub-carboniferous.
T. minor, N. and W. Sub-carboniferous.

Genus PŒCILODUS, Ag.

P. ornatus, N. and W. Sub-carboniferous.
P. rugosus, N. and W. Sub-carboniferous.

Genus DELTODUS, N. and W.

D. grandis, N. and W. Sub-carboniferous.
D. stellatus, N. and W. Sub-carboniferous.
D. undulatus, N. and W. Sub-carboniferous.
D. rhomboideus, N. and W. Sub-carboniferous.
D. cingulatus, N. and W. Sub-carboniferous.
D. spatulatus, N. and W. Sub-carboniferous.
D. angularis, N, and W. Sub-carboniferous.
D. complanatus, N. and W. Sub-carboniferous.

Family CHIMEROIDEI.

Genus RINODUS, N. and W.

R. calceolus, N. and W. Devonian.

RELATIONS UNCERTAIN.

Genus EDESTUS, Leidy.

E. minor, Newb. Coal Measures.

FIN SPINES.

Genus ORACANTHUS, Ag.

O. pnigeus, N. and W. Sub-carboniferous.

Genus [illegible], Ag.

[illegible], N. and W. Sub-carboniferous.

Genus [illegible], Ag.

[illegible], N. and W. Sub-carboniferous.
[illegible], N. and W. Sub-carboniferous.
[illegible], N. and W. Sub-carboniferous.

Genus [illegible], Ag.

[illegible], N. and W. Sub-carboniferous.
[illegible], N. and W. Sub-carboniferous.

Genus DREPANACANTHUS, N. and W.

[illegible], N. and W. Sub-carboniferous.
[illegible], N. and W. Sub-carboniferous.
[illegible], N. and W. Coal Measures.

DERMAL TUBERCLES.

Genus PETRODUS, McCoy.

[illegible], N. and W. Coal Measures.
[illegible], N. and W. Coal Measures.

SUPPLEMENT

TO THE DESCRIPTIONS OF VERTEBRATES.

BY PROF. EDWARD D. COPE.

Class REPTILIA.

Sub-class BATRACHIA.

ORDER *XENORHACHIA.*

GENUS AMPHIBAMUS, Cope.

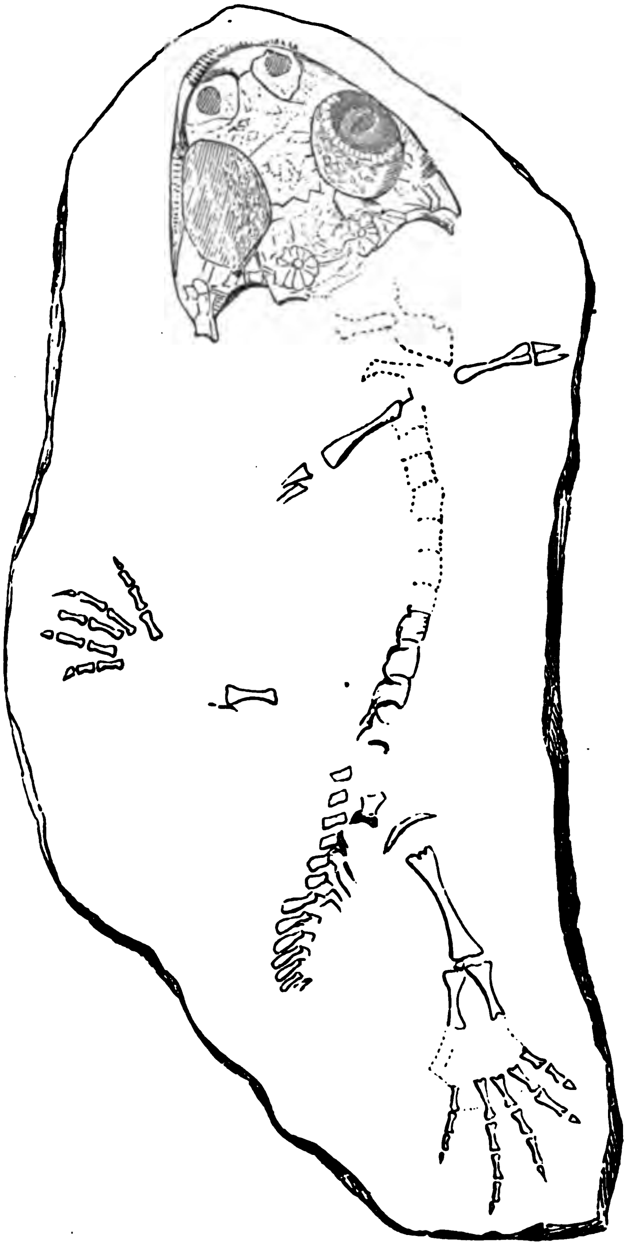
AMPHIBAMUS GRANDICEPS, Cope.

Pl. 32, fig. 8, and cut on p. 136.

Amphibamus grandiceps, Cope, (Proc. Acad. Nat. Sci., Philad., 1865, p. 134.)

The recent additions to our knowledge of the air-breathing vertebrates of the Carboniferous period, are of great interest to the comparative anatomist, as furnishing new points in the series of structures between the *Ganoidea* and *Lacertilia*, or new "generalized" types combining the structures of these and of the *Batrachia.*

NOTE.—A single specimen of the *Batrachian* here described is in possession of Mr. Joseph Even, who has kindly placed it temporarily at the service of the Survey. It was discovered by him near Morris, Grundy county, Illinois, in a bed belonging apparently above the middle of the Coal Measures. It is imbedded in a concretion of brown ironstone. The cavities left by the bones are occupied by a white friable mineral, which has probably percolated into them.—A. H. W.



Amphibamus grandiceps, (mag. 2 diam.)

The above cut is given to illustrate more clearly some points of structure, not readily shown in a shaded engraving. It, however, represents the little scales of the right palpebra, above the marginal row, too large and too scattering.

This animal combines with its *Batrachian* a few *Lacertilian* characters, having some resemblance to Dawson's genus *Hylonomus*, and much affinity with Prof. Wyman's *Raniceps Lyellii*. Its squamous integument and narrow nasal roof give it the somewhat *Lacertilian* physiognomy, more especially *Geccotian*, in its broad cranium and orbits, its large marginal palpebral scales, and rather short digits. Its true affinities are indicated by the presence of two premaxillaries, with a squamoso-postorbital arch, as in *Labyrinthodontia*, some *Batrachia Gradientia*, and *Crocodilia;* its quadratojugal arch, as in *Labyrinthodontia* and *Batrachia Salientia;* its posteriorly directed oblique quadratum and lack of ribs, as in *Batrachia Salientia;* its probably short pelvis, short separate bones of the leg and fore-arm; its opisthocœlian dorsal vertebræ, and long caudal neural spines, as in *Batrachia Gradientia*. It is then the type of a group intermediate between the *Labyrinthodontian* and *Gradient Batrachians*, distinguished from the former by the opisthocœlian vertebræ, absence of ribs, and pleurodont dentition; and from the latter by the scaly integument, absence of ribs, and structure of the nasal and pre-frontal regions. But one genus of Salamanders, *Glossolega*, has a similar os fronto-squamosal or posterior zygomatic arch. A ribless type might, however, well exist among *Gradientia*, when we consider the great difference between their development in *Pleurodeles* on the one hand, and *Amphiuma* on the other. From the *Salientia* the dentigerous mandible, squamosal arch, form of vertebræ, sacrum and extremities, etc, widely distinguish it. To the *Batrachian* orders *Labyrinthodontia*, *Gradientia*, *Gymnophidia* and *Salientia*, the present may be added, under the name *Xenorhachia*.

The general form of the skull is much that of a frog, and large in proportion to the size of the animal; its length is one-half that of the spinal axis from the occiput to the middle of the sacral region, and five-sixths its own breadth in the flattened specimen. The outline is not broadly rounded, as is usual among Salamanders, but is slightly contracted, as in many frogs. The orbits are large, regularly rounded their longitudinal diameter one and one-half times the frontal width; their point of nearest approach is behind, opposite the position of the iris; one diameter, measured obliquely in advance of each, extends a little beyond the common premaxillary suture.

The premaxillary bones have considerable horizontal extent, terminating opposite the narial openings, each bearing eleven or twelve teeth. Their nasal spines were in close contact, and do not appear to be prolonged backwards, as in most *Gradientia*. The external nares are rather widely separated, as in most *Gradientia*, the integument, which they pierced, roofing a large space between the median and peripheric bones of the muzzle. The roof of the nasal cavities is a truncate cuneiform plate, whose apex joins that of the premaxillaries. Its composition can only be conjectured, from the appearances presented by the specimen. It may be a superior ethmoid plate, as in the frogs *Borborocœtes* and others, or, more probably, a united or separate pair of free frontal, as in *Dactylethra* or *Rana*. There is no trace of the composition of nasals and frontals, which occurs in the *Gradientia*, nor is such an arrangement probable, in view of the regular elongate cuneiform outline of this singular piece. A moderately distinct suture, crossing the front at the anterior third of the interorbital space, which presents a regular convexity forwards, appears to be the anterior border of the frontal; the latter can scarcely be an interorbital plate of ethmoid, as it appears to unite behind by suture with the parietals. There are bosses on the pre-frontal region, indicating pre-frontal or "lachrymal" bones, similar to those in *Sceloporus* and other *Lacertilian* genera.

What may possibly be the coronal suture, since it appears to be too regular to be a fracture, crosses the narrowest part of the interorbital space. It is a zigzag, presenting posteriorly a median angle, and one on each side. The posterior zygomatic arches are strong, and bound a cranial plane, which is broader than long, and exhibits nearly parallel lateral outlines. The probably small "crotaphite foramina" of the temporal fossæ appear to have been roofed over by perhaps the strong scales of the cranial integument. The quadratum is convex externally, and is directed obliquely backward to opposite the occiput; it is strongly concave in its posterior outline, indicating a large auricular meatus. Whether this was covered by scales or by an exposed tympanic drum, cannot be determined. The quadratojugale is broad and strong. The postorbital arch is continuous with the quadratum; the breadth of the two equals the frontal width. The angular process of the mandible is but little prolonged beyond the quadratum. The maxillary is toothed, at least as far as opposite the malar process.

The dentition is pleurodont; the teeth are only visible on the mandible and the outer edge of the upper jaw; they are there of but one kind, small, closely set, acute-conic, not compressed, hollow, and without any inflections of the enamel.

The integument of the head was squamous. The scales appear not to have been imbricate, and were perhaps more dense on the posterior regions, where their position is occupied by the white material mentioned in Prof. Worthen's note, which has here a somewhat ganoid appearance. They were more elongate on the muzzle. There appears to have been a distinct superciliary, and a postorbital row, as well as a series on the border of the upper lip. A whorl of elongate scales, arranged like the pieces of an arch, surrounded the one on each side which marked the crotaphite foramen. In the specimen these are connected by a suture or line, which is regularly convex posteriorly. The superior palpebræ were covered by small separated scales, as are seen among *Geccos* and *Anoles*, and were bordered by a larger and continuous series, of about fourteen subquadrate scales. These have evidently bordered the lid, extending transversely across the orbit, and were not sclerotic scales, which are arranged round the pupil as a centre.

The vertebral column is much injured, especially in the cervical region. The dorsal vertabræ appear to have been short, and probably thirteen in number between the interscapular and sacral regions. They appear to have been constricted medially. Traces of ribs or of transverse processes are not to be found. The impression of a sacral vertebra is distinctly preserved. The caudal vertebræ were perhaps without osseous centra, as no definite impressions can be traced, and their place is occupied by the matrix. There are traces of osseous neural arches, perhaps similar to those of *Archegosaurus*, and apparently disconnected, long, compressed neural spines, and slender pleurapophyses; the latter were probably united as chevron bones. Of the former, twelve very distinct impressions may be counted to the sacral region; the posterior are most slender, the median most elevated, the anterior lower and of greater longitudinal extent. They are more expanded in the direction of the axis of the body near their superior extremities, and evidently supported a flattened natatory tail, as that of *Protonopsis*. These neural spines were continued on the posterior third of the dorsal series. The visible, which is probably the greater part of the tail, enters the remainder of the column two and a quarter times, by measurement.

Sternal and hyoid pieces are not recognizable, though sundry fragments are no doubt to be referred to these regions. An impression resembling that of a raniform scapula, was probably made by that piece. The anterior limbs were short and weak. The humerus is slender; its length equals the distance between the centres of the external nares; it is apparently not much dilated, nor furnished with a process proximally, but is dilated and grooved distally, and has no condyles. The ulna and radius are separate and slender; the distal extremities of these, with the remaining bones of the anterior limbs, have been lost.

Of pelvis nothing is recognizable. The femur is slender, much dilated distally, slightly curved in the posterior direction, and without condyles. Its length is equal to the breadth of the cranial table.

The tibia and fibula are one-half the length of the femur, are slender, most dilated proximally; the antero-exterior bone is a little longer, not in contact with the inner distally, which relation I believe to be normal. The tarsus was probably cartilaginous, as in *Protonopsis* (*Menopoma*,) a faint impression of the outer border remaining. It was broader than long, and without heel-like projections.

While the great shortness of the lower leg is a Salamandrine peculiarity, the length and slenderness of the digits are quite Lacertian. The leg being extended backward, the exterior or first digit is shortest, and a little less than the second. This is equal to two and one-half phalanges of the fifth (reckoning from its base) or the proximal pair of phalanges of the fourth. The fifth is a little shorter than the third, which is scarcely equal to the three proximal phalanges of the fourth. The number of phalanges 3—3—4—5—4: among the Salamanders the last two numbers are usually 4—3. They are without condyles, but exhibit one or two emarginations at their articulating surfaces. The length of the basal phalanx of the first digit is two-thirds that of the second; the latter equals that of the fifth and the second phalanx of the fourth; these are very little shorter than the basal of the third and fourth. The terminal phalanges are elongate acute, those of the first and fourth slightly curved. They are much less obtuse than in Salamanders, and the animal has probably had weak claws; of these no trace remains.

A few traces indicate that the dermal integument was covered, on the anterior part of the body, at least, with small and sub-granular scales. There have been abdominal scales arranged in narrow imbricate series, directed inward and posteriorly. Traces of plates are wanting, excepting a small fragment lying beside the cervical vertebræ.

The length of this species from the sacral centre to the interscapular region was 13 lines; from the latter point to the end of the muzzle, 12 lines; to the occipital border, 4–5 lines. Longitudinal diameter of orbit, 3 lines; frontal breadth, 2 lines; from border of orbit to border of nostril, 1–5 lines; breadth of cranial table, 3–75 lines. Length of humerus, 3 lines; of femur, 3–6 lines; of tibia, 2–3 lines; of fifth digit, 2–75 lines; of fourth. 4–2 lines; of first, 1–8 lines. The portion of the tail preserved measures 5–2 lines.

If we compare the peculiarities of this genus with those of the *Batrachia* of the same period, we find it to be distinguished, independently of the ordinal characters, from such genera as *Osteophorus*, *Melosaurus* *Sclerocephalus*, *Xestorrhytias*, *Baphetes* and *Brachyops*, by the absence of the sculpturing of the cranial bones, the lack of dermal shields, characteristic of most of these, and by the presence of cranial and palpebral scales. The crania of the first genera are much more elongate, and imitate those of some *Crocodilia*. Similar differences exist between the Illinois *Batrachian* and *Dendrerpeton*, Owen; the latter possesses, also, a double row of teeth. *Hylonomus*, Dawson, supposed to possess *Lacertilian* affinities, exhibits ribs and biconcave vertebræ. The ribs of *Telerpeton* will distinguish it also. The only genus as yet known to approach closely that under consideration has been described by Prof. J. Wyman under the name of *Raniceps*.* This animal is only known from a study of the inferior aspect of a portion of the skeleton; nevertheless it is certainly different, being nearly double the size, and having relatively longer and stronger anterior limbs. The angles of the mandible appear to have been considerably more incurved than in the Illinois species. They may have belonged to the same genus; in that case the name here given will not prove superfluous, as the older appellation was previously applied to a genus of *Gadid* fishes.

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* Silliman's Journal Sci. Arts, 1858, p. 158.

The name *Amphibamus grandiceps* has reference, first, to its two modes of progression; its flattened oar-like tail enabled it to swim in the waters of the swamps of the coal period, and its elongate, clawed digits indicate ambulatory power; perhaps it climbed upon the low limbs of the *Sigillariæ* that rose above the water. The animal was most probably nocturnal in its habits. The humors of the eye could not have escaped far beyond their natural envelopes, so that the subsequently formed limestone has been hardened, and so fractured in nearly the form of the ball. On the fractured surface, below and under the remaining palpebral scales, the mineral is distinctly blackened, as by the *pigmentum nigrum;* below the margin of the lid this is interrupted by a discoid spot of the form and dimensions of an iris, which presents a median lenticular vacuity, again revealing the pigment, obviously the vertical pupil of a nocturnal animal. The preservation of the outline of color is certainly remarkable in a specimen of such great antiquity. A somewhat parallel case occurs in the preservation of the ink-bags of the *Sepiæ;* but these do not date further back than the Jurassic. These appearances can not be explained on any supposition of accidental production.

PALÆONTOLOGY OF ILLINOIS.

SECTION II.

DESCRIPTIONS OF INVERTEBRATES FROM THE CARBONIFEROUS SYSTEM.

BY F. B. MEEK AND A. H. WORTHEN.

INVERTEBRATE FOSSILS OF THE KINDERHOOK GROUP.

PROTOZOA.

SPONGIÆ.

PETROSPONGIA.

GENUS SPHENOPOTERIUM, M. and W.

[*σφην*, a widge; *πυτηριον*, a drinking cup.]

Sphenopoterium, MEEK and WORTHEN, Oct., 1860. Pro. Acad. Nat. Sci., Philad., p. 447.

MORE or less cuneate, or irregularly subturbinate, with a few rounded cells or cup-like cavities, opening upwards, or in part, somewhat laterally. Substance comparatively dense, and perforated by irregular pores or small canals. Walls of cells with more or less obscure vertical striæ within. External surface marked by fine irregular, anastomosing, somewhat granular striæ.

In first proposing the above generic name for the reception of a species of this group from the Keokuk limestone, we supposed the obscure striæ seen within the cells might be the remains of rudimentary septa, and hence regarded it as most probably a coral. On taking up the group for more careful study at a later date, and comparing the several known species with various groups of corals, with the view of determining the affinities of the genus, we were unable to find any section of corals apparently bearing even remote relations to it, and sent specimens of the typical species to Prof. A. E. Verrill, of Yale College, who has devoted especial attention to the corals, with the request that he should give us some suggestions respecting its affinities. From as careful an examination as could be made without preparing sections for the microscope, Prof. Verrill writes that he thinks it most probably a sponge, and not a coral, which view we have adopted on his authority. Prof. V. says he is not acquainted with any nearly allied genus, but that it is remotely allied to some of the Jurassic forms.

So far as known at present, the range of this genus is from the Kinderhook division of the Subcarboniferous series to the Chester limestone of the same.

SPHENOPOTERIUM ENORME, M. and W.

Pl. 14, Fig. 1 *a*, 1 *b*.

Sphenopoterium enorme, MEEK and WORTHEN, Oct., 1860. Proceed. Acad. Nat. Sci., Philad. p. 448.

SMALL, sub-globose or obtusely subturbinate; irregularly rounded and apparently retaining remains of a scar of attachment at the base. Cells four or more, rounded, conical, of moderate depth, and rather irregularly disposed. Surface striæ, rather distinct, and broken up into irregular granules. Length or height, about 0.48 inch; greatest transverse diameter, about 0.43; breadth of cells, near 0.18 inch.

Locality and position: Rockford, Indiana, Gonialite bed, of the Kinderhook group, Subcarboniferous series. Also, in same horizon at Clarksville, Missouri.

SPHENOPOTERIUM ENORME, *var.* DEPRESSUM.

Pl. 14, Fig. 2 *a*, 2 *b*.

THIS form may possibly belong to a distinct species, but with the specimens we have yet seen, for comparison, we are inclined to regard it as only a variety of the last. It differs mainly in being more depressed, and in having its base flattened, or truncate instead of irregularly conical. Its cells are also more regularly disposed in a quadrangle, and more nearly on a plane.

Locality and position: Salt Lick Point, Monroe county, Illinois, in same position as last.

RADIATA.

ECHINODERMATA.

CRINOIDEA.

GENUS ACTINOCRINUS, Miller.

Synon.—*Actinocrinites*, MILLER, 1821. Nat. His. Crinoidea.
Actinocrinus, AGASSIZ, 1835. Mem. Soc. Sci. Neuchat., 1.
Melocrinites, (sp.), GOLDF., 1839. Act. Nat. Curios., XIX; (not 1826 Petref. Germ. 1, p. 197.)
Melocrinus, (sp.), BRONN, 1848. Nom. Palæont. 1, p. 719; (not Ag. 1835.)
Abracrinus, D'ORBIGNY, 1850. Palæont. Stratigr. 1, p. 156.
Conocrinus, TROOST, 1850. List Crin. Tenn. Proc. Am. Ass., Cambridge, p. 60.
Batocrinus, CASSEDAY, 1854. Zeitschr. Deutsch. Geol. Gessellsch, VI, p. 237.
Eretmocrinus, LYON and CASSEDAY, 1859. Am. Jour. Sci., (2), Vol. XXVIII, p. 241.
Alloprosallocrinus, LYON and CASSEDAY, 1860. Am. Acad. Arts and Sci., Vol. V, p. 29.
Uperocrinus, MEEK and WORTHEN, Aug., 1865. Pro. Ac. Nat. Sci., Philad., p. 153.

* *Generic Formula.*—
Basal pieces, 3.
Subradials, 0.
Radials, 3+5.
Secondary do., 0 to 1 or 2+10. (Sometimes 1 in 3 rays, and 2 in each of the others.
Interradials, 1 to 13, or more.
Anal pieces, 3 to 15, or more; the first one resting on the base.
Opening of summit, sub-central or central—with or without a proboscis.
Arms, 12 to 30, or more.
Column, round, with a cylindrical or more or less pentagonal cavity.

Body, when divested of the arms and column, presenting every diversity of form, from sub-globose to fusiform, conic, sub-discoid, wheel-shaped, pyriform, etc. The three basal pieces are arranged so as to form a flattened hexagonal disc, or a more or less elevated cup. Of the five first radial pieces, three are generally hexagonal, and rest upon the truncated upper side of the basal piece, while the other two are heptagonal, and rest upon the base so as to occupy more or less defined retreating angles or notches at the sutures dividing the basal pieces. Second primy radials hexagonal, pentagonal or quadrangular; while the third, upon which the first bifurcation takes place, are pentagonal, hexagonal, or heptagonal. The secondary radial pieces, which are sometimes, though rarely, wanting, usually vary from one to two in each division of each ray, and support the brachial pieces, excepting where other divisions take place upon intervening pieces.

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* It is very probable that at least a part of the characters generally expressed in what are now called the generic formulæ of Crinoids, will be found to be rather family characters than generic.

Anal plates varying in number in the different species; the first being usually nearly or quite as large as the first radials, with which it also corresponds in resting directly down upon the basal pieces. Interradials equally variable in number, according to the species, and to some extent in different individuals of the same species; the first is nearly always larger than the others, and rests between the superior lateral sloping sides of the first radial pieces.

Arms varying in number from twelve to thirty or more, and with rare exceptions all simple after becoming free;—always composed, excepting at their bases, each of a double series of small interlocking pieces, which support tentacles along their inner sides.

Vault composed of variously formed pieces, sometimes in part swelling out into more or less prominent nodes, or even short spine-like projections, either terminating in a slender, more or less elongated, sub-central proboscis, having the opening at its summit, or with a simple sub-central opening, without a proboscis.

Surface of body plates ornamented with radiating costæ, nodes or granules, or sometimes nearly or quite smooth.

As in other allied types, the visceral cavity is known to have been (in some species at least) provided with a curious convoluted plate, connected with the digestive apparatus. For an illustration of this organ, as seen in the genus *Strotocrinus*, see a wood cut given in another part of this volume, in connection with the description of that genus.

The foregoing description is drawn up so as to exclude some types usually included in this genus, but which, we think, should be separated as distinct genera. Even as here defined, however, it is susceptible of division into several sections and subordinate groups, as follows:

1. **ACTINOCRINUS**, Miller, (proper.)

a.—Groups of arm bases, forming five distinctly separated prominent lobes, sometimes including the adjacent parts, in to the third primary radial pieces; second primary radials nearly always hexagonal; vault provided with an elongated sub-central proboscis, with the opening at its summit; body plates generally ornamented with radiating costæ.

Actinocrinus triacontadactylus, Miller; *A. dorsatus*, *A. stellaris* and *A. armatus*, de Koninck; *A. Lowii*, Hall; *A. concinnus* and *A. multiradiatus*, Shumard?

b.—Differs from the above in having the arm bases not projecting in lobes, and much less distinctly in groups, or sometimes forming a nearly continuous series.

A. proboscidialis, *A. clarus*, *A. sexarmatus*, *A. costatus* and *A. multibrachiatus*, Hall; *A. Hurdianus*, McChesney; *A. polydactylus*, Miller, etc.

c.—Agrees with the last, excepting in having the sub-central opening of the vault simple or without a proboscis.*

Actinocrinus ornatus, *A. cancellatus* and *A. ventricosus*, Hall; *A. subventricosus*, McChesney.

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* We are in considerable doubt in regard to the nature and importance of the difference between species with a simple opening, near the centre of the summit, and those provided with an elongated central or subcentral proboscis, with the opening at its extremity. At one time we were inclined to think this a character of considerable importance, indicating fundamental differences in the structure of the animal; but the fact that we find this difference occurring in various genera of palæozoic crinoids, even after being carefully restricted and grouped upon all other characters, has led us to doubt its value as a generic distinction, and even to suspect that it might have been in some cases a sexual difference, since the *Echinodermata* are known to have the sexes distinct. Yet the specific relations of the forms thus distinguished do not seem to sustain this supposition; while the well-known fact that the reproductive organs in the recent *Crinoidea* are not located within the body, but on the tentacles of the arms, renders it very improbable that the presence or absence of a proboscis could have depended upon the sex of the animal. In a few rare cases species like *Actinocrinus oblatus*, Hall, which have a very slender proboscis, seem to have had that appendage sometimes accidentally broken away, during the life of the animal, so that the fractured edges of its base become absorbed and round in such a manner as to present

2. **BATOCRINUS**, Casseday—(*Eretmocrinus*, Lyon?)

a.—Arm bases not separated into groups or projecting as lobes, but forming a nearly or quite continuous series all around; body basin-shaped below the arms and about as prominent as the vault; second primary radial pieces almost invariably quadrangular, and generally wider than long; body plates often tumid, but never marked with radiating costæ; proboscis well developed.

Actinocrinus (*Batocrinus*) *icosidactylus* and *A.* (*B.*) *irregularis*, Casseday; *A. clypeatus*, *A. formosus*, *A. æqualis* and *A. discoideus*, Hall, etc.

b.—(*Alloprosallocrinus*, Lyon and Casseday=*Conocrinus*, Troost.) Only differs from *Batocrinus* proper in being flat below the arm bases.

A. conicus and *A. depressus*, Lyon and Casseday; *A. euconus*, M. and W.

c.—(*Uperocrinus*, M. and W.) Differs from *Batocrinus* proper in having the body below the arms very narrow, and drawn out so as to form a kind of handle to the upper part.

Actinocrinus pyriformis, Shumard; *A. pistillus* and *A. pistilliformis*, M. and W.

d.—Differs from *Batocrinus* proper in being sub-globose, or depressed so as to become wheel-shaped; also, in having its body plates less tumid or quite even, and the base more rounded; very rarely with the interradial spaces emarginated, so as to give a stellated outline, as seen from above or below.

Actinocrinus rotundatus, Shumard; *A. similis*, *A. inornatus*, *A. biturbinatus*, *A. sinuatus* and *A. planodiscus*, Hall; *A. Christyi*, Shumard; *A. æquibrachiatus* and *A. Hageri*, McChesney; and *A. asteriscus*, M. and W.

We are very much inclined to the opinion that the *Batocrinus* group should stand as a distinct genus, but as it seems to shade into *Actinocrinus* proper, through section *b* of that genus, and palœontologists have generally included it, we have concluded to place it, for the present, as a section, under *Actinocrinus*. It is worthy of note, however, that it is an American group, and is apparently confined to the Sub-carboniferous rocks. It includes, as we have defined it, a rather wide range of forms, some of which, like our *A. asteriscus*, if compared without the intermediate links, would seem to be very distinct from the typical species; and yet such forms shade, by easy gradations, through *A. æquibrachiatus*, McChesney, *A. Christyi*, and various less depressed species, into *A. rotundatus*, and so on through the whole series, so that there seems to be no sufficiently defined break to warrant the division of the group even into well marked sub-genera.

The genus *Actinocrinus*, as we have defined it, is readily distinguished from our *Steganocrinus*, by the remarkable, greatly extended, free, covered rays of

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exactly the appearance of a naturally simple opening, without any traces of a proboscis. This we believe to be the case with the specimen of *A. Hageri*, figured by McChesney. That the difference alluded to, however, could have been thus produced in the typical *Actinocrini*, in *Strotocrinus* and various other genera, no one would for a moment believe, after examining good species.

that type; and from our *Strotocrinus*, by the curious expansion of the summit of the latter, formed by the numerous divisions of the rays (with their intermediate pieces), between the third primary radials and the free arms. From *Amphoracrinus* and *Agaricocrinus*, it is easily distinguished by the lateral opening of the summit, and general physiognomy of these types. From *Megistocrinus*, as properly resticted, it can in most cases, be distinguished by the position and nature of the opening of the summit, as well as by the mode of division of the rays previous to giving off the free arms, and by differences in the general physiognomy of the entire body. From *Macrostylocrinus*, Hall, (*Cytocrinus*, Roemer), it is distinguished by the having its first anal plate resting down upon the base. From *Saccocrinus*, with which it agrees in the number and arrangement of its basal, primary radial, and interradial plates, it differs in the irregular manner of the divisions of the rays, and the disposition of their pieces, between the third radials and the base of the free arms in that genus.

M. M. de Koninck and Lehon, in their valuable work on the *Crinoidea* of the Carboniferous rocks of Belgium, express the opinion that the genus *Actinocrinus* is confined to the Carboniferous system. In this country, however, we have evidence of its existence as early as during the deposition of the Upper Silurian rocks; several species are also known in our Devonian series. It was during the Subcarboniferous epoch, however, that it attained its greatest develment, particularly while the Burlington limestone was forming. We know of no species of the genus higher in the series than the St. Louis limestone, and the only two species yet found in that rock, belong to the *Batocrinus* division.

SUBGENUS BATOCRINUS, Casseday.

SEC. C. (UPEROCRINUS, M. and W.)

ACTINOCRINUS PISTILLIFORMIS, M. and W.

Pl. 14, Fig. 8.

Actinocrinus pyriformis, var. *rudis*, MEEK and WORTHEN, June, 1861. Proceedings Acad. Nat. Sci. Philad., p. 131; (not *A. pyriformis*, SHUMARD, Geol. Report Missouri, p. 192, 1855; nor *A. rudis*, Hall, Sup. Iowa Report, p. 33, 1860.)

Actinocrinus pistilliformis, M. and W., Aug., 1865. Pro. Acad. Nat. Sci. Philad., p. 153.

BODY, exclusive of the proboscis, pyriform, being very narrow and apparently cylindrical from the base to the top of the third radial plates, above which the secondary radial, and brachial pieces, curve abruptly outwards to the base of the arms, so as to form, with the ventricose summit, a much expanded visceral cavity, entirely above the basal and primary radial plates.

Base unknown; first radials unknown, excepting from some remaining portions of their upper ends, which show that they are comparatively large. Second radials very small, a little wider than long, (those seen) irregularly pentagonal in form, one of the sides being much shorter than the others. Third radials as long as the first, and nearly one-third wider; the only two visible in our specimen hexigonal in form, and each supporting on its superior sloping sides two secondary radials of about its own size. Each of these is surmounted by a somewhat larger second secondary radial, which in its turn supports two first brachial pieces, each of which is succeeded by a second, from which the free arms are given off. The two series of secondary radials, and the four series of brachial pieces in each ray, coming in contact laterally, leave no room for interaxillary and interbrachial pieces. Interradial plates two or three, the first being about the same size as the second radials, and hexagonal or heptagonal in form. Above this there is one or two small pieces of variable size and form, over which the secondary radials, and the lateral series of brachial pieces of the rays on each side, connect all the way up to the free arms, in such a manner as to leave no spaces for interradials, above those just described. (Anal plates unknown.)

Dome hemispherical, composed of pentagonal, hexagonal and heptagonal plates of nearly uniform size, each of which is provided with a spine-like tubercle. Proboscis central, or nearly so. Arm openings twenty. Surface smooth or obscurely graulose; small rather pointed tubercles are also seen on the second and third radial plates, first interradials, and first secondary radials.

In first describing this species, we regarded it as a variety of *A. pyriformis*, Shumard, for which we proposed the name *rudis*, not being aware at that time that Prof. Hall had used that name for another species in his Supplement to the Iowa Report. Later comparisons, however, led us to the conclusion that it is specifically distinct from Dr. Shumard's *A. pyriformis*, and as the name *A. rudis* could not be retained for it, we proposed to call it *A. pistilliformis*. It differs from *A. pyriformis*, Shumard, in the subspiniferous character of its plates, and in the possession of only two or three interradial plates, instead of six in each interradial space. It also differs in having a more ventricose dome, while the inferior half of its body is more abruptly contracted below the arms.

Locality and position: Salt-Lick Point, Marion county, Illinois; Kinderhook group, of the Subcarboniferous series.

MOLLUSCA.

BRACHIOPODA.

GENUS RHYNCHONELLA, Fischer, 1809.

(Mem. Soc. Imp., Moscou, ii.)

RYNCHONELLA MISSOURIENSIS, Shumard.

Pl. 14, Fig. 4 *a*, 4 *b*.

Rhynchonella Missouriensis, SHUMARD, 1855. 2d Ann. Rep. Geol. Survey Missouri, p. 204, pl. C, fig. 5 *a*.

SHELL subtrigonal, subglobose or moderately gibbous; lateral margins rounded; front somewhat truncated, or a little sinuous in outline; postero-lateral margins converging to the beaks at an angle of about 114°. Dorsal valve more convex than the other, sometimes very gibbous, mesial elevation rather obscure, rarely extending beyond the middle of the valve, occupied by from two to three (rarely four) rounded plications, which generally become obsolete near the middle of the valve; anterior margins on each side of the mesial ridge provided with one or two obscure plications; beak not prominent. Ventral valve moderately convex in the umbonal and antero-lateral regions, and depressed in the middle towards the front, so as to form a rather broad, rounded, moderately deep sinus, occupied by from one to three obscure rounded plications, usually not extending up to the middle of the valve; front curving down and more or less produced in the middle, in the form of a semicircular or subquadrate projection, fitting into a corresponding sinus in the margin of the other valve; antero-lateral margins each occupied by two obscure, usually short, rounded plications; beak short, small, and closely incurved upon that of the other valve. Surface apparently smooth, or having only a few subimbricating marks of growth near the front, but showing under a lens traces of exceedingly fine, nearly obsolete, radiating striæ, which are also visible on the laminæ of partly exfoliated specimens. Length (of a gibbous specimen), 0.50 inch; breadth, 0.56 inch; convexity, 8.40 inch.

This shell varies considerably in form, and in the distinctness of its plications, some individuals being much more gibbous than others; while in some examples (particularly young shells) the plications are almost entirely obsolete, and in others more distinctly defined, and extending farther up towards the beaks. The obscure, minute, radiating striæ, mentioned above, seem to be produced by the fibrous structure of the shell, rather than by true surface markings, since they are visible on all the laminæ of exfoliating specimens. On protected portions of well preserved specimens, we have also thought we could sometimes see traces of minute, concentric striæ, by the aid of a good lens.

We are not quite sure Dr. Shumard is right in regarding figure 5*b* and 5*c*, plate C, of the Missouri report, cited above, as a variety of this species, since we have not seen all the intermediate gradations connecting these forms.

After a careful comparison of the shell under consideration, with a fine series of *Rhynchonella reniformis* and *R. pugnus*, sent by Mr. Davidson, from the Carboniferous limestone of England and Ireland, it seems to us that it will be difficult, if not impossible, to distinguish it from certain varieties of both of these forms, which are themselves regarded by some authors as only varieties of one species.

Locality and position: Rockford, Indiana, in the *Goniatite* bed of the Kinderhook group, Subcarboniferous series; also at the same horizon at Chouteau Springs, and numerous other localities in Missouri.

GENUS SPIRIFER, Sowerby, 1815.

(Mineral Coch., ii, p. 42.)

SUBGENUS MARTINIA, McCoy.

Martinia, McCoy, 1844. Carb. Foss. Ireland, p. 139.
Ambocœlia, Hall, 1860. Thirteenth Ann. Report Regents Univ., N. Y., p. 71.

SPIRIFER COOPERENSIS, Swallow.

Pl. 14, Fig. 5*a*, 5*b*.

Spirifer Cooperensis, Swallow, 1860. Trans. St. Louis Acad. Sci., Vol. 1, p. 643.
Spirifer semiplicata, Hall? Dec., 1860. Thirteenth Ann. Report of the Regents Univ. N. Y., p. 111.

SHELL small, transversely subelliptical, gibbous, greatest breadth generally a little above the middle; lateral margins rounded, converging somewhat towards the front, which is subtruncate or slightly sinuous in the middle; hinge considerably shorter than the breadth of the shell, rounded at the extremities. Dorsal valve depressed-convex, provided with a low, scarcely defined mesial elevation, on each side of which are two or three depressed, rounded, obscure plications, rarely traceable to the umbo; beak nearly obsolete, or very small, and scarcely distinct from the cardinal margin; area small, not incurved. Ventral valve considerably more gibbous than the other, provided with a moderately distinct shallow mesial sinus, which commences very narrow near the beak, and widens rather rapidly to the front, its deepest part being along the middle; lateral slopes on each side of the sinus, having three or four very obscure, depressed plications, similar to those on the other valve; beak prominent, distinctly incurved beyond the hinge line; area small, triangular, arching back over the hinge, moderately well defined; foramen triangular, nearly as wide at the hinge line as on each side, apparently always open. Surface having a few subimbricating concentric marks of growth, and showing, under a magnifier, indistinct granulations. Some specimens have faint indications of two plications within the ventral sinus. Length, 0.38 inch; breadth, 0.35 inch; convexity, 0.26 inch.

As remarked by Prof. Swallow, this species resembles *S. lineatus*, Martin (sp.), but differs materially in the possession of obscure radiating plications, and in being more distinctly inequivalve. Young specimens also resemble somewhat *S. Urei*, Fleming,* but they may always be readily distinguished from that shell by their plications.

Locality and position: Same as last.

LAMELLIBRANCHIATA.

GENUS CARDIOPSIS, M. and W.

Cardiopsis, MEEK and WORTHEN, June, 1861. Proceed. Acad. Nat. Sci., Philad., p. 144.

SHELL equivalve, somewhat inequilateral, very slightly oblique, ovate or cordiform, entirely closed; beaks rather elevated, distinctly incurved and directed towards the anterior side; surface marked by radiating striæ or costæ; cardinal margin short and rounding into the posterior border; hinge provided with one or two distinct anterior teeth in each valve, near the beaks. (Ligament and muscular impressions unknown.)

In first describing the species we regard as the type of this genus, we placed it provisionally in the genus *Cardiomorpha*, deKoninck, stating at the same time that we suspected it to be generically distinct. Prof. Hall has since described the same species, from the same locality, in the Thirteenth Annual Report of the Regents of the University of New York, under the name of *Megambonia Lyoni*,† and mentions the presence of two strong anterior teeth in the hinge of one valve. On clearing away the matrix from the hinge of one of our specimens, we have been able to see traces of the impressions of these teeth, the presence of which establishes, we think, the correctness of our suggestion that it does not properly belong to the genus *Cardiomorpha*.

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* Mr. Thomas Davidson, of London, after a careful comparison of specimens from Illinois, states that he regards *Ambocœlia gemmula* of McChesney, (which had been previously described by Dr. Shumard, in the Missouri Report, under the name of *Spirifer planoconvexus*), as identical with *Spirifer Urei* of Fleming.

† The genus *Megambonia* was founded upon *Pterinea cardiiformis*, Hall, belonging apparently to the *Arcidæ* or *Aviculidæ*.

It is not improbable that some of the species ranged by Prof. de Koninck in his genus—when all their characters can be made out—may be found congeneric with our shell; though it is manifest those he considered the typical species are not, since he distinctly states that the hinge is without teeth, and provided with a smooth lamina from the beaks to the posterior extremity, as some of his figures show. In addition to this, all the species described by him, (with one single exception, which is a transverse shell, and apparently a wide departure from his typical species, as well as from ours,) are merely marked by concentric striæ, and show no traces of the regular radiating costæ seen on our shell.

CARDIOPSIS RADIATA, M. and W.

Pl. 14, Figs. 6*a*, 6*b*.

Cardiomorpha radiata, MEEK and WORTHEN, Oct., 1860. Proceedings Acad. Nat. Sci., Philad., p. 448. (Not *C. radiata*, DE KONINCK, 1844. An. Foss., p. 109.)

Megambonia Lyoni, HALL, Dec., 1860. Report Regents University, New York, p. 110.

SHELL sub-circular, gibbous in the central and umbonal regions, a little higher than wide, slightly oblique; basal border more narrowly rounded than the front and anal margins; hinge border short, apparently a little arched; beaks gibbous, rising somewhat above the hinge, abruptly pointed, incurved, and showing a tendency to curve forward at the immediate points; surface ornamented by numerous fine, regular, rather rounded radiating striæ, some seven or eight of which may be counted in the space of 0.20 inch, at the middle of the base. Height, about 1.05 inch; length, 0.95 inch; breadth or convexity, near 0.76 inch.

This species is more like *Cardiomorpha ovata*, Hall, (Iowa Report, p. 522, pl. 7, fig. 10*), from the same horizon (now made the type of a new genus *Dexiobia*, by Prof. Winchell), than any other shell with which we are acquainted, but is more nearly circular in form, has more depressed beaks, and much coarser and more distinct striæ, while its umbonal slopes are less prominent.

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* Not *C. ovata*, d'Orbigny.

Locality and position: Rockford, Indiana, in the *Gonaitite* bed of the Kinderhook group; also, in the same horizon at Grafton, Jersey county, Illinois. Subcarboniferous.

GASTEROPODA.

GENUS STRAPAROLLUS, Montfort, 1810.

(Conch. Syst., ii, p. 174.)

IF we could rely upon the accuracy of Montfort's figure and description of the type of his genus *Straparollus* (*S. Dionysii*), little doubt could be entertained in regard to its being entirely distinct from *Euomphalus*, Sowerby, as represented by Sowerby's typical species *E. pentangulatus*, *E. catillus*, and *E. nodosus*. As Prof. de Koninck, however, after enjoying the advantage of studying collections from Montfort's original locality (Namur), gives figures of *S. Dionysii*, Montfort (Foss. An. Belg., pl. xxiv.), showing the form of the aperture, and the nature of the lower part of the lip to be quite different from what we see in Montfort's figure, and more nearly as in the types of *Euomphalus*, we are probably warranted in adopting the conclusion that these forms are congeneric, and that Montfort's figures are, as usual, defective. Still, after admitting the correctness of Prof. de Koninck's identification, and the accuracy of his figures, we can but regard the original types of *Euomphalus*, with their greatly depressed or nearly planorbicular form, and angular whorls, almost equally visible on either side, as at least subgenerically distinct from the type of *Straparollus*, with its rounded or non-angulated whorls, smaller umbilicus, and more prominent spire. Hence we think the name *Euomphalus* should be retained, in a subgeneric sense, under *Straparollus*, for the group of which *E. pentangulatus*, of Sowerby, is the type.

We are aware Prof. McCoy, and some others, regard *Euomphalus* as typified by *E. pentangulatus*, as an *exact* synonym of *Straparollus*, and that he proposes to transfer the former name to another group, consisting of rough, Cirrus-like shells, of which *E. discoris* and *E. rugosus*, Sowerby, are examples. (See Brit. Pal. Foss., p. 279). It seems to us, however, that if the name *Euomphalus* is to be retained at all, we should apply it to the forms for which it was originally proposed, and that we have no right to transfer it to another type, because Sowerby subsequently, in another place, refers this other type to his genus *Euomphalus*. If we regard *Straporollus*, Montfort, 1810, and *Euomphalus*, Sowerby, 1815, as exactly synonymous, then the latter name should be dropped from use, except in the synonymy of *Straparollus*, and could not, according to the most generally accepted rules of nomenclature, be transferred to the *E. discoris* group, whether we view these shells as constituting a section of the genus *Straparollus*, or as an entirely distinct genus.

A marked subgenus, apparently of this group, from the Carboniferous rocks of California, was described by one of the writers (F. B. M.) under the name *Omphalotrochus*, in volume 1 of the Palæontology of that State, p. 15, and figured on pl. 2, fig. 8, 8*a*, of the same report. It is a large, very ponderous shell, having much the form of a depressed *Pleurotomaria*, with a deep, conical umbilicus, and whorls flattened and biangular around the outer side. Another species of the same type was described by d'Orbigny, from the Carboniferous rocks of Bolivia, under the name *Solarium antiquum*. (See *Voyages dans l'Amerique Merid., p.* 42, *pl.* 3, *figs.* 1, 3.)

STRAPAROLLUS LENS, Hall, (sp).

Pl. 14, Fig. 7 *a*, 7 *b*.

Euomphalus lens, HALL, Dec., 1860. Thirteenth Ann. Rept. Regents Univ. N.Y., p. 109.

SHELL rather under medium size, lenticular; spire much depressed, or rising little above the body whorl; volutions about four, increasing moderately in size, nearly flat, with an outward slope above—the slope being about coincident with that of the spire—last one angular around the periphery, and rather distinctly convex and rounded below; suture (in casts at least) well defined; umbilicus deep, less than the breadth of the outer whorl at the aperture. Surface unknown. Aperture transversely subovate, or subrhombic in outline. Height of one of the largest specimens, 0.35 inch; greatest breadth, 0.60 inch; height of aperture, 0.19 inch; breadth of aperture, 0.25 inch.

The only specimens of this species we have seen not being in a condition to show the nature of the lip, or the surface lines of growth, it is difficult to determine, very satisfactorily, its generic relations. It has the form of some of the lenticular species of *Pleurotomaria*, but there are no evidences manifest, in any of the specimens we have examined, of a spiral band, as in that genus; hence it seems to belong to a palæozoic group of lenticular forms, usually referred to *Euomphalus*, as that name is generally used in its widest signification. It is not a typical *Euamphalus*, however, and if falling within the genus *Strap-*

allous, should be regarded as belonging to a distinct section from the type of that genus.

Locality and position: Same as last. Also in the Chouteau limestone of Moniteau and other adjoining counties of Missouri, and in the same position in this State.

GENUS BELLEROPHON, Montfort, 1810.

(Conch. Syst., ii, p. 174.)

BELLEROPHON CYRTOLITES, Hall.

Pl. 14, Fig. 8 *a*, 8 *b*.

Bellerophon cyrtolites, HALL, Dec., 1860. Thirteenth Ann. Report Regents University N. Y., p. 107.

SHELL small, sub-lenticular; sides converging with a slightly convex outline, from near the umbilicus to the prominent angular periphery; volutions apparently about two and a half, increasing rather rapidly in size, each of those within, about three-fourths embraced by the succeeding turn, last one becoming obtusely angular around the umbilicus; aperture cordate; lips broadly and deeply sinuous at the dorsal angle; umbilicus (in casts) about one-third the breadth of the outer whorl, deep and conical; surface of casts retaining obscure traces of marks of growth, which in crossing the sides of the whorls from the umbilicus, make a graceful curve forward, and in approaching the dorsal angle, curve very strongly backwards, so as to indicate the presence of a very profound but not sharply defined sinus, in the lip. Greater diameter of a large specimen, 0.66 inch; breadth at the aperture, 0.35 inch.

This species belongs to a section of lenticular species, for which one of the writers has proposed the name *Tropidodiscus*,* with *B. curvilineatus*, of Conrad, as its type. These shells differ from the type of the genus *Bellerophon* (*B. vasulites*), Montfort, in their lenticular form, often carinated dorsum without a defined band, open umbilicus, and in not having the inner lip callous and spread over the inner whorls. They seem also to have been thinner shells than the typical Bellerophons, and may belong to an entirely distinct genus.

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* Proceed. Chicago Acad. Sci., Vol. 1, p. 9, March, 1866.

Specifically, the form under consideration seems to approach *B. Deslonchampsii*, d'Orbigny, from the Upper Silurian, (referred by that author to *Cyrtolites*, of Conrad), but has its dorsum more angular, and its aperture narrower, than d'Orbigny's species.

Locality and position: Rockford, Indiana; in the *Goniatite* bed of the Kinderhook group. Subcarboniferous.

CEPHALOPODA.

GENUS NAUTILUS, Linnæus, 1758.

(Syst. Nat. Ed., 10, t. I, p. 709.)

SUBGENUS TREMATODISCUS, M. and W.

Trematodiscus, MEEK and WORTHEN, 1861. Proceed. Acad. Nat. Sci., Philad., p. 147.

WE proposed to range under the above subgeneric name, a peculiar group of *Nautili*, which differ so materially from the living typical species of *Nautilus*, that few Conchologists would place them even in the same genus, if they were found inhabiting our present seas. These shells are characterized by a discoid form, and a wide, shallow umbilicus, usually, if not always, perforated in the middle, and showing all the inner turns. Their whorls are slender, very slightly embracing or merely in contact, and provided with revolving angles and grooves; while the surface is frequently ornamented with distinct revolving striæ. The siphuncle is central, or located between the middle and the dorsal side, though never quite marginal.

In first publishing descriptions of some of the forms included in this subgenus, we proposed to retain for it Prof. King's abandoned name, *Discus*. As this name had, however, been previously used by Fitzinger in 1833, for a group of *Helicidæ*, and by Prof. Haldeman in 1840, for a group of *Limnæidæ*, it became necessary to introduce a new name for the forms under consideration.

Although in some respects analagous to *Discites*, of McCoy, these shells differ from the typical forms of that group in having a perforated umbilicus; while the whorls are less compressed, narrower, and provided with several distinct revolving angles and grooves. They also differ in being often ornamented with well defined revolving lines.

In the perforated character of the umbilicus, the shells of this group may not differ from some other sections of discoid fossil *Nautili*, but in the possession of several distinct revolving grooves and angles, with strong longitudinal striæ, they seem to be quite peculiar. The group appears to be mainly, if not almost exclusively confined to the Carboniferous system, and will include the following foreign species: *Nautilus stygialis*, *N. Edwardsianus*, *N. Omalianus* and *N. pinguis*,* de Koninck, together with *N. sulcatus*, *N. cariniferus*, etc., of Sowerby.

After proposing the foregoing name and description for this ancient group of *Nautili*, we observed that Prof. McCoy had proposed in his "Carboniferous Fossils of Ireland," p. 20, 1844, the name *Temnochielus*, for a group of Carboniferous species, including some of the same species for which our name *Trematodiscus* was proposed. As his subgenus, however, embraced a much wider diversity of forms than ours, it may be found convenient to restrict it to such types as his first species *N. biangulatus*, *N. pinguis* (McCoy, not de Kon.), and *N. globatus*, as proposed by one of the writers (Palæont. Up. Mo., p. 64), during the past year; while *Trematodiscus* may be retained for the forms agreeing with the types for which it was proposed.

As noticed in the Palænt. Up. Mo., above cited, Blainville had in 1824 (Dect. Sc. Nat. Tom. XXXII, p. 185), included some of the same forms falling within the group *Trematodiscus*, in Montfort's proposed genus *Simplegades*, but it is evident from Montfort's figure and description, that his type of *Simplegades*, was an *Ammonite* or a *Ceratite*, and hence his name could not properly be retained for the forms under consideration.

G. B. Sowerby (Conch. Man., 276, 1842) also falls into the same error, and places *Nautilus sulcatus*, Sowerby, under Montfort's name *Simplegas*, or *Simplegades*, and yet admits that Montfort's type has sinuous septa like the *Ammonites*.

NAUTILUS (TREMATODISCUS) TRISULCATUS, M. and W.

Pl. 14, Fig. 10 *a*, 10 *b*, 10 *c*.

Nautilus (Discus) trisulcatus, MEEK and WORTHEN, Oct., 1860. Proc. Acad. Nat. Sci., Philad., p. 470.

Nautilus (Trematodiscus) trisulcatus, M. and W., June, 1861. Ib., p. 148.

SHELL under medium size, discoidal; umbilicus wide, of moderate depth, and showing nearly all of each inner whorl, volutions slender, increasing very gradually in size, a little broader transversely than the diameter from the dorsum to the ventral margin, somewhat ventricose and rounded on each side, and provided with a deep rounded sulcus along each dorso-lateral margin. Between these two sulci the dorsum is narrow, prominent, and less deeply concave, the sulcus being bounded on each side by an angle. Surface retaining traces of rather strong, regular, longitudinal lines. Septa deeply concave, moderately close—their margins arching distinctly backwards in each of the dorsal depressions. Siphuncle rather small, and placed a little nearer the dorsal than the ventral side. Greatest diameter of a specimen retaining about one-third of the outer chamber, 2.23 inches; breadth of last whorl, about 0.87 inch.

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* Not *N. pinguis*, McCoy.

This species bears some resemblance to certain varieties of *N. sulcatus*, of Sowerby, as figured by deKoninck (An. Foss., pl. XLVII, fig. 10, and pl. XLVIII, figs. 8 and 9), but differs in the number and arrangement of its revolving angles, and in the possession of longitudinal striæ. It is still more nearly allied to *N. Edwardsianus*, de Koninck (Sup. An. Foss., pl. LIX, fig. 7 *a*, *b*, *c*,), but differs in having less compressed whorls, which are rounded instead of angular around the umbilicus; while its dorsal carinæ are less prominent. Our specimen being merely a cast, we have no means of determining how near these two forms may have agreed in the details of their surface markings.

Locality and position: Rockford, Indiana, in the *Goniatite* bed of the Kinderhook Group, Subcarboniferous series.

NAUTILUS DIGONUS, M. and W.

Pl. 14, Fig. 9*a*, 9*b*, 9*c*, 9*d*.

Nautilus (*Discus*) *digonus*, MEEK and WORTHEN, Oct., 1860. Proc. Acad. Nat. Sci., Philad., p. 470.

SHELL small, subdiscoidal; umbilicus comparatively large, showing all of each inner whorl, apparently perforate; volutions slender, increasing very gradually in size, a little broader transversely than the diameter from the dorsum to the ventral margin, nearly flat, and provided with two shallow longitudinal grooves on the dorsal side, and distinctly angular around each dorso-lateral margin, thence rounding regularly into the umbilicus. Surface of cast retaining traces of regular, equidistant, longitudinal lines, and much finer closely arranged transverse striæ. Aperture and section of the whorls nearly semicircular, the outer or dorsal side being almost straight, and the inner rounded. Septa distinctly concave on the side next the aperture; their margins curving abruptly forward in crossing the dorso-lateral angles, thence deflected backwards in the dorsal grooves, and passing nearly straight across the middle of the dorsum. Siphuncle small, located about one-third the diameter of each septum from the dorsal side. Length, or greatest diameter of a specimen, about one-third of the outer whorl of which is non-septate, 1.25 inches; height, 1 inch; breadth across the outer whorl, near the aperture, 0.62 inch; diameter of same from the dorsal to the ventral side, 0.40 inch.

Prof. Hall figures in the Thirteenth Ann. Report Regents University N. Y., p. 105, under the name of *Gyroceras gracile*, a fragment of a shell apparently related to this species. As he does not say, however, in his brief description, whether it has rounded or angular whorls, and his figure is merely an outline wood cut, we are left in some little doubt whether it may not be a fragment of a variety of the species before us, especially as it came from the same locality and position, and appears to agree in its surface markings. The measurements of its proportional vertical and transverse diameters, however, would seem to indicate narrower whorls and a more compressed form than in our shell, while his figure represents the undulations of the septa in crossing the dorsum as differing somewhat from those of our species. If they should prove to be identical, however, our name will have to take precedence, since our description was published more than a month in advance of Prof. Hall's. Even if specifically distinct, we have little doubt in regard to the shell described by Prof. Hall belonging to the same group as ours.

Locality and position: Rockford, Indiana, in the *Goniatite* bed of the Kinderhook Group. Subcarboniferous. Also, at the same horizon in Jersey county, Illinois, and at several places in Central Missouri.

GENUS GONIATITES, de Haan.

Goniatites, DE HAAN, 1825. Monogr. *Ammonites et Goniatites*.
Aganides [?], MONTFORT, 1808. Conch. Syst., I, p. 30.

IF it could be demonstrated that *Goniatites*, de Haan, is synonymous with *Aganides*, of Montfort, as is believed by some eminent Palœontologists, we would be compelled by the law of priority to adopt Montfort's name for the genus. The locality cited by Montfort (Namur, Belgium), would certainly favor the conclusion that his type was a *Goniatite*; but as neither his figure, nor his description, enables us to decide beyond doubt, whether it was a *Goniatite*, or, as Hermannsen and others maintain, an *Aturia*, we do not feel warranted at present in adopting his name for the *Goniatite* group. Indeed his figure shows apparently some faint indications of a nearly central siphuncle. If this is not merely an accident of shading, and was really intended to indicate the position of the siphuncle, it would settle the question that it was at least not a *Goniatite*, and that Montfort must have been mistaken in regard to the locality from which his type was obtained. Until this question can be more definitely settled, we prefer to retain de Haan's name *Goniatites* for this genus.

GONIATITES LYONI, M. and W.

Pl. 14, figs. 11*a*, 11*b*, 11*c*.

Goniatites Lyoni, MEEK and WORTHEN, Oct., 1860. Proc. Acad. Nat. Sci. Philad., p. 471.
Goniatites hyas, HALL, Dec., 1860. Thirteenth Ann. Rept. Regents Univ. N. Y., p. 102.

SHELL compressed, discoidal; umbilicus large or nearly twice the breadth of the outer whorl from the dorsal to the ventral side, shallow and showing about four-fifths of each inner whorl. Volutions slender and increasing very gradually in size, compressed or about one-third deeper from the dorsal to the ventral side than the transverse diameter; rather narrowly rounded on the dorsum, and provided with a shallow concavity along the inner side for the reception of each succeeding inner whorl. Septa moderately distinct, and deeply divided into six* lobes and six saddles; dorsal lobe longer than wide, infundibuliform and acutely pointed; dorsal saddle as long as the dorsal lobe, but wider and rounded at the extremity; superior lateral lobe lanceolate, a little longer than the dorsal lobe, acutely pointed at the end and somewhat contracted above; lateral saddle linguiform, longer and narrower than the dorsal saddle; inferior lateral lobe similar to the superior, excepting that it is somewhat smaller; ventral saddle shorter and broader than the lateral saddle, slightly oblique, and rounded at the end.

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* The sixth lobe is at the middle of the ventral side, and not visible externally.

As remarked by Prof. Hall, this species bears some remote relations to *Goniatites chemungensis* of Vanuxem (Report 3d Geol. Dist. N. Y., p. 182), but differs very materially in the number of its lobes, there being five or six visible in each septum on each side of Vanuxem's species, and only two in ours. It is much more nearly like *G. mixolobus*, Phillips, as figured in his Palæozoic Fossils, pl. LI, fig. 235 *b*, and Geol. Yorks., part II, pl. XX, fig. 43–47; but presents well defined differences in its septa, particularly in the dorsal lobe. Phillips's species is said to occur both in the Carboniferous and Devonian rocks of England.

As our description of the species under consideration was printed and distributed more than a month in advance of the publication of Prof. Hall's figures and description, our name will have to take precedence, in accordance with the established usages of naturalists.

Should it ever be demonstrated that Montfort's type of *Aganides* was a true *Goniatite*, the name of the species here described will of course become *Aganides Lyoni*, since Montfort's name has priority of date.

Locality and position: Rockford, Indiana, from the *Goniatite* bed of the Kinderhook group. Subcarboniferous.

INVERTEBRATE FOSSILS OF THE BURLINGTON GROUP.

RADIATA.

ECHINODERMATA.

CRINOIDEA.

GENUS DICHOCRINUS, Miller.

Synon.—*Platycrinus* (var.), MILLER, 1821. Nat. Hist. Crinoidea, 114; (not ib. p. 74.)
Platycrinus (sp.), PHILLIPS, 1836. Geol. Yorks., II; AUSTIN (sp.), 1843, Monogr. Crinoidea.
Dichocrinus, MUNSTER, 1838. Bietrag. Z. Petref., 1.
? *Cotyledonocrinus*, CASSEDAY and LYON, 1859. Am. Acad. Arts and Sci., vol. iv, p. 26.

The generic formula of this group, given by M. M. de Koninck and Lehon, in their valuable "*Recherches sur les Crinoides du Terrain Carbonifere de Belgique,*" p. 146, is as follows:

Basal pieces, 2.
Radial pieces, 4, one of which is large, +5.
Interradial pieces unknown.
Anal pieces, 1 known, very large, resting on the base.
Number of arms, 10.

Since this formula was published, a number of species have been described in this country, some of which seem to show that it should be slightly modified, probably as follows:

Basal pieces, 2.
Radial pieces, 2 to 4? +5; the first always much larger than the others.
Interradial pieces, 4 to 5.
Anal pieces, 1 to 5; one large and resting on the base.
Arms, 10, bifurcating.

From what is now known, this genus may be described as follows: Basal pieces two, hexagonal, and forming when united, an obconic or more or less depressed cup. The five first radial pieces very large, resting directly upon the base, two upon each basal piece, and the anterior one in a notch at one end of the suture between the latter. Succeeding radial pieces one to three in each ray,* very small, the last supporting the arms, which in the typical forms of the genus, are slender and more or less frequently bifurcating. First anal piece nearly or quite as large as the first radial, and resting upon the base between them, in a notch at one end of the suture between the basals; the remaining anals small, and not very distinct from the vault pieces. Interradials four or five, very small, and similar to the vault pieces, resting in small notches at the superior lateral angles of the first radials.

The vault of *D. pocillum*, Hall, is described as consisting of few plates; one between the bases of each two of the arms being larger than the others, while on the anal side, it has numerous small plates with a minute opening, and the whole crowned by a single, much larger plate than any of the others. Several of the species described by Casseday and Lyon, seem to have a similar vault.

Austin's figures of *D. elongatus*, would appear to have the vault terminated by a moderately produced proboscis, with a rounded entire extremity; but as he says some of his specimens (including the one from which the figure alluded to was drawn) have but five pieces in the next range about the base, it is probable the one figured with a proboscis is a true *Platycrinus*.

In the simplicity of the structure of its body, this genus resembles *Platycrinus* and *Hexacrinus*, but is readily distinguished from both by its bipartite base. It is more nearly allied, however, to *Pterotocrinus*, of Lyon, with which it agrees in the number of its basal pieces, and in having the five first radial, and the first anal pieces resting directly upon the base. It differs, however, widely in the structure of the parts above, particularly in not possessing the greatly developed interbrachial appendages of *Pterotocrinus*, and in having the radial pieces above the first one always well developed. The general form of the entire body in these two genera, is likewise very different.

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* Mr. Lyon has suggested that there may be some error in Austin's figures representing four primary radials, in their *D. fusiformis*, which is certainly very probable, since none of the other species are known to have more than three of these pieces to each ray; and as but one species is supposed to have only two, it is highly probable that the normal number is three.

The proposed genus *Cotyledonocrinus*, Cassedy and Lyon, appears to agree exactly in all respects with *Dichocrinus*, excepting that it has no anal piece on a range with the five first radials, and in contact with the base. This feature, however, as suggested by Dr. Shumard, is probably abnormal. If not, it may be a good generic distinction.

So far as known, the genus *Dichocrinus* was peculiar to the Carboniferous epoch.

DICHOCRINUS CONUS, M. and W.

Pl. 16, Fig. 5 *a*, 5 *b*.

Dichocrinus conus, MEEK and WORTHEN, Sept., 1860. Proc. Acad. Nat. Sci., Phil., p. 381.

BODY large, abconical, longer than wide, composed of rather thin smooth plates, connected by close fitting linear sutures. Base comparatively large, a little wider than high, tapering rather rapidly to the small inferior extremity, which is truncated, and provided with a small, slightly projecting rim; both pieces presenting a subtrigonal general outline, though really hexagonal, if we count the slightly salient angles between the shallow sinuosities in the upper margins; columnar facet small, round, or a little oval. Radial pieces large, longer than wide, presenting an oblong outline, slightly wider above than at the base; all more or less convex on the inferior margin, which in the anterior ray is provided with an obtuse mesial angle; sinus in the upper edge of each, for the reception of the succeeding range of plates, near one-third as wide as the superior margin, and excavated down about one-fifth the length of the plate, its lower edge projecting rather distinctly outwards. First anal plate as large as the first radials, and having much the same form, excepting that it is provided with a distinct mesial angle above, as well as below.

Each first radial, as well as the first anal plate, has an obscure, rounded prominence, extending down the middle to its base, so as to give the body a slightly hexagonal outline as seen from below. These prominences are also continued on down upon the basal pieces, gradually becoming obsolete as they converge towards the narrow lower extremity. Length, to the summit of the first radial pieces, 1.28 inch; breadth, about 1.16 inch; height of base, 0.58 inch; breadth of do., 0.76 inch.

This species is so nearly like *Dichocrinus lævus*, Hall (Sup. Geol. Report, Iowa, part 2, p 83), that we were at one time inclined to think it might belong to the same species. A more careful comparison, however, with the original specimen from which Prof. Hall's description and diagram were made out, leads us to regard it as distinct. In the first place, the specimen under consideration is much larger than that described by Prof. Hall, and differs in having the second radials more deeply inserted into the upper margins of the first. It likewise differs in the possession of obtuse ridge-like prominences down the middle of the first radial and first anal plates. Again, its first anal plate terminates in a mesial angle above, instead of being truncated, and a little excavated in the middle.

It is perhaps more nearly allied to *D. intermedius*, de Koninck and Lehon (*Crinoides Ter. Carb. Belg.*, p. 150), though it differs in having deeper and narrower sinuses in the upper margins of the first radials. It also differs in having the upper extremities of the first radials and first anal plate more incurved, and in the possession of an obtuse mesial prominence on each of these plates.

Locality and position: Burlington, Iowa, Burlington Limestone, of Lower Carboniferous series.

GENUS PLATYCRINUS, Miller.

Synon.—*Astropodium* (sp.), URE, 1793. Hist. Rutherglen, p. 326; (not Defrance, 1819.)
Nave Encrinite, PARKINSON, 1811. Organic Remains, II, p. 223.
Platycrinites, MILLER, 1821. Nat. Hist. Crinoidea; Schlot., 1823, Nachtr. Zur Petrefakt. Th., 1, 1822, and others.
Platycrinus, AGASSIZ, 1834. Mem. Soc. Sci. Nat. Neuch., 1, p. 197, and others.
? *Marsupiocrinites*, PHILLIPS, 1839. Murch. Sil. Syst., p. 672.
Centrocrinus, AUSTIN, 1843. Mongr. Recent and Foss. Crinoidea, p. 6.
Pleurocrinus, AUSTIN, 1843. Ib.
Edwardsocrinus, D'ORBIGNY, 1850. Prodr. Palæont. Strat. 1, p. 157.
? *Cupellæocrinus*, (TROOST), SHUMARD, 1865. Cat. Palæozoic Foss., part 1, Ech., p. 361.

The following is the formula of this genus, as given by de Koninck and Lehon, in their "*Recherches Sur les Crinoides Carb. de la Belgique:*"

> "Basal pieces, 3, forming an expanded cup.
>
> Radials, 2[*]. (one of which is large, and one small) +5.
>
> Anals, 1 large, or 3 small.
>
> Interradials, 1+4.
>
> Number of arms, 10, 20, 30 or 35, according to the species."

Column generally round near the body, more or less compressed, and often tortuous below. Base pentagonal, depressed, basin-shaped, or nearly flat, composed of one small quadrangular piece and two larger pentagonal pieces, all of which are generally anchylosed. First primary radials large, and resting on the base; second primary radial pieces small, trigonal or pentagonal, and occupying a depression in the upper margin of each first radial—usually supporting on their sloping sides the first divisions of the arms.

Arms ascending, or often, at first, extending nearly or quite horizontally from the body, and bifurcating more or less frequently, according to the species; all the divisions being provided with tentacles.

Dome composed of numerous irregular pieces, usually tubercular, or sometimes forming spines; ventricose, more or less depressed, or often produced in the form of an extended cylindrical proboscis. Opening lateral, or nearly central.

As first proposed by Miller, this genus was badly defined, and it is manifest that its author himself had no very clear ideas of its limits, since he also included in it species of *Pentremites*, Say, *Dichocrinus*, Munster, and of his own genus *Actinocrinus*. Later writers, however, have restricted it within far more natural limits, and, as now generally understood, Miller's first species, *P. lævis*, seems to be regarded as the typical form of the genus. In this and the closely allied species, the body is more or less hemispherical below the arms, while the dome terminates above in a long, generally stout, central or subcentral proboscis, closed at the summit, but apparently pierced by a small aperture on one side, near the upper extremity. In these typical forms the arms bifurcate once, or oftener, near the body, beyond which they are simple, and composed at first of a single series of wedge-shape pieces, passing more or less gradually into a double series of small interlocking pieces, supporting numerous tentacles. Other species, however, generally included in the genus, have no proboscis, but a simple aperture in the summit, located either laterally or nearly centrally; while some of these have the arms composed of a double series of interlocking pieces, and others of a single series of wedge-shaped pieces,* neither of these peculiarities in the structure of the arms being always especially coincident with apparently any one of the other characters mentioned.

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[*] It is worthy of note that although de Koninck and Lehon give two radials (one large and one small) as the number, that their Fig. 1, Pl. VI, of *P. lævis*, Miller, shows clearly 3 radials, one large and two small. As others figure and describe it as having only two, this may be only an abnormal variety. It will be seen, however, that our *P. parvulus*, described on page 163 of Proceed. Acad. N. S., Philad., Aug., 1861, also has three primary radials to each ray, while the arms are composed each of a single series of pieces.

From the foregoing remarks it will be seen that the group, including species agreeing with the given formula, may be divided, as (in part) suggested by the Messrs. Austin, into the following four sections: †

1. **PLATYCRINUS,** (typical.)

With the summit terminating in a more or less elongated, central or subcentral proboscis, bearing the opening on one side, near the upper extremity.

Type. *P. lævis*, Miller; also includes *P. spinosus* and *P. 30-dactylus*, Austin; *P. Mullerianus*, de Koninck, and *P. granulatus*, Miller.

2. **CENTROCRINUS,** AUSTIN.

Opening of summit nearly or quite central, but not elevated upon a proboscis.

Type. *P.* [*Centrocr.*] *gigas*, Gilbertson.

3. **PLEUROCRINUS,** AUSTIN.

Differs from *Centrocrinus* mainly in having the opening of the summit lateral, and nearly or quite on a line with the arm bases.

Examples: *P.* [*Pleurocr.*] *mucronatus*, Austin; *P.* [*Pleurocr.*] *tuberculatus*, Miller; *P.* [*Pleurocr.*] *tuberosus*, and *P.* [*Pleurocr.*] *subspinosus*, Hall; *P.* (*Pleurocr.*) *asper*, Meek and Worthen, etc., etc.

4. **MARSUPIOCRINITES,** PHILLIPS.

a —Differs from *Platycrinus* proper only in having its second radial pieces merely rudimentary, or so small as to allow the first brachials to rest partly upon the first radials.

Type. *M. cœlatus*, Phillips.

b.—(*Cupellæocrinus*, TROOST,) Differs from the last only in having a subcentral opening without a proboscis.

Type. *P. Tennesseensis*, Roemer.

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* *P. nodobrachiatus*, Hall, Iowa Report, p. 542, 1858 (not *P. nodobrachiatus*, Hall, 1861;=*P. perasper*, M. and W., 1865), is an American example of this genus, with a single series of pieces in each arm. It is worthy of note, that the type of *Edwardsocrinus*, d'Orbigny, has arms composed each of a single series of pieces, though it was not upon this character, but upon the erroneous supposition that it had five basal pieces, that he proposed to separate it from *Platycrinus*.

† Monogr. Recent and Fossil Crinoidea, p. 6.

In regard to the value and importance of the characters distinguishing these sections, Palæontologists will probably always differ. Hitherto these differences have scarcely been noticed, even by the most respectable authorities, excepting as one of the means of distinguishing species. From all analogy, however, it seems reasonable to suppose that they were accompanied by corresponding modifications in the structure of the softer parts of the animal. It will also be observed that they correspond, in part, almost exactly to the characters distinguishing divisions of the allied *Actinocrinus* group. For instance, the species embraced in the section *Pleurocrinus* differ from the typical forms of *Platycrinus*, almost precisely as *Agaricocrinus* and *Amphoracrinus* do from the typical species of *Actinocrinus*.

The genus *Platycrinus* seems to have been introduced during the Upper Silurian Epoch, though these earlier species generally depart more or less from the typical Carboniferous forms, as we see in the type of the subgenus *Cupellæocrinus*, for instance, and *P. plumosus*, Hall. The Devonian species hitherto referred to this genus, are said by de Koninck to all belong to the allied genus *Hexacrinus*. This group certainly attained its maximum development during the Carboniferous Epoch, which it seems not to have survived.

SUBGENUS PLEUROCRINUS, Austin.

PLATYCRINUS SUBSPINOSUS, Hall.

Pl. 15, Fig. 6.

Platycrinus subspinosus, HALL, 1858. Geol. Report Iowa, Vol. I, part II, p. 536, pl. 8, figs. 9 and 10.

BODY, including the summit and second radials, subhemispherical, being nearly flat below and gibbous above; decahedral in outline, as seen from beneath, with the arms and second radials removed. Base pentagonal in outline, flat or scarcely visible in a side view, broadly and deeply concave in the middle; margins distinctly beveled; sutures a little impressed near the beveled lateral margins. First radials hexagonal, as seen from below, joining nearly horizontally around the base, but curving abruptly upwards on each outer lateral margin to connect with the interradial and crown pieces, where they have each an addition lateral angle, not visible from beneath; lateral and inferior (inner) margins distinctly beveled, like the basal pieces. Second radials about half as large as the first, from the truncated outer ends of which they extend out nearly horizontally, or even decline slightly below the horizon of the base, presenting a pentagonal inferior view, and curving strongly upwards on each side to connect with the vault pieces. Interradials rather small, hexagonal or heptagonal, and rising vertically from the upturned edges of the first radials. Anal piece not much larger than the interradials, and apparently octagonal.

The arms, after the first bifurcation on the second radial pieces, extend out horizontally, or even decline a little at first, and then curve gradually upwards; they all bifurcate regularly again on the second piece, the inner subdivisions generally bifurcating a third time on the second piece, while one, or sometimes two of these subdivisions divide again, so as to make 37 (probably sometimes 40) arms in the entire series. The arms are rounded on the outside, gradually tapering; and immediately after the last division, each is at first composed of one, two, or three wedge-formed pieces, beyond which they soon pass into a double series of small alternating pieces, supporting on the inner side a double row of thick, closely-arranged tentacles.

The summit is composed of various formed plates, each of which rises in the middle into a short spine or prominent tubercle. These pieces extend out from the vault, so as to form the summit of each ray nearly to the second bifurcation. The anal opening is small, lateral and surrounded by small, rather protuberant pieces. Entire surface finely and rather obscurely granulose.

We are under obligations to Mr. Charles Wachsmuth, of Burlington, Iowa, for the use of the beautiful, unique specimen from which our figure and description of this species have been made out. It is one of the finest, if not the finest specimen of *Platycrinus* ever found, being so completely detached from the matrix that almost every part of the skeleton, excepting the column, which is wanting, can be seen nearly as well as in a living *Crinoid.* It is evidently closely related to *P. discoideus* of Owen and Shumard (Owen's Report Wisconsin, Iowa and Minnesota, p. 588, pl. 5 A, fig. 1*a*, 1*b*), with which Dr. Shumard thinks it may be identical; but as neither the specimen described by Prof. Hall, nor that figured by us, shows any traces of the peculiar ridges and other sculpturing seen on the first radial pieces of *P. discoideus*, we think these forms specifically distinct.

Locality and position: Burlington, Iowa; Burlington limestone, of Lower Carboniferous series.

GENUS CYATHOCRINUS, Miller.

Synon.—*Encrinus* (sp.), Ure, 1793. History of Rutherglen; (not of others).
Encrinites (sp.), Schlot, 1813. Jahrb, 91–89; Petrefact., 1820; (not Miller and others.)
Cyathocrinites, Miller, 1821. Nat. Hist. Crinoidea, p 85; Quenst., 1835, Wegm. Arch., p. 11, 89.
Cyathocrinus, Agassiz, 1834. Mem. Soc Sc. Nat. Neuch., ii, and others.
Pachycrinites, Echwald, 1840. Bull, St. Petersb. vii, p. 78.
?*Eupachycrinus*, Meek and Worthen, 1865. Proeeed. Acad. Nat. Sci. Philadelphia, p. 159.

Generic formula.—
Basal plates, 5.
Subradials, 5.
Radials, 3 + 5, the first large and the others small.
Anal pieces, 2 or 3.

The base in this genus is composed of five pieces, which are generally of equal size and form, and united so as usually to present a pentagonal outline. Subradial plates five, alternating with the basal pieces; four of them more or less distinctly hexagonal, and one heptagonal, the latter being generally truncated above for the reception of the first anal piece, and sometimes supporting on its right superior sloping side, a subanal piece intercalated between it and one of the first radials. First radial plates large, truncated and more or less sinuous above, for the reception of the second radials, usually all alternating with the subradials. Second and third radials small, the third being pentagonal or subtrigonal, and supporting the arms. First true anal plate resting upon the truncated upper side of one of the subradials, and inserted between two of the first radials. The arms are usually strong and variously branched, each division being probably always composed of a single range of pieces.

The vault is composed of a comparatively small number of pieces, and is provided with a central oral, and an entirely distinct, lateral anal opening, one of which is, according to de Koninck and Lehon's description, and Austin's figures, produced in the form of a short proboscis.

In the number and arrangement of the pieces composing that portion of the body below the arm bases, this genus is very similar to *Poteriocrinus*, but in the structure of the upper part of the body, these two groups are remarkably distinct. For instance, the vault of *Cyathocrinus* is comparatively very low, or merely arched a little above the attachment of the arm bases, and provided with a central or subcentral oral opening, sometimes a little produced as a short proboscis, and an entirely distinct lateral anal opening; while in *Poteriocrinus* the whole summit is enormously extended in the form of a great proboscis, often as wide as the entire body, or sometimes much wider above, and nearly or quite as long as the arms, with (according to Austin) a single opening at its summit. These we regard as the most important differences between these two genera.

Other less striking differences, however, are usually observable between the species of these groups, such, for instance, as the more obconical form of the body in the typical species of *Poteriocrinus*, which also generally have one or two more anal pieces included in the walls of the body, below the summit of the first radial pieces, than in *Cyathocrinus*. Again, in most cases, they likewise have one of the first radials (that on the right of the anal series) resting upon the truncated upper extremity of one of the subradials, instead of all alternating with the subradials as is usually the case in *Cyathocrinus*. These latter peculiarities of structure, however, are not constant in either of these groups.

The genus *Cyathocrinus*, as properly restricted, seems to be, as maintained by M. M. de Koninck and Lehon, Pictet and some others, mainly, if not entirely, confined to the Carboniferous and Permian rocks. We are aware several species have been referred to it from the Silurian and the Devonian strata, but nearly all of these not clearly belonging to other established genera, present more or less marked differences in the parts known, from the typical Carboniferous species; while none of them are known to possess the two distinct openings in the summit, charactorizing the typical species of *Chathocrinus*.

The only Silurian species known to us, referred with probable correctness to this genus, the arms of which have been discovered, is *C. bulboses*, Hall (Fifteenth Report Regents Univ. N. Y., p. 123, pl. 1. fig. 19–20), from the Upper Helderberg rocks. In this the hemispherical or bulb-like body is extremely small compared with the remarkably robust arms, which are long, spread out horizontally, and bifurcate several times without diminishing in size, so that it is manifest they could not have been capable of being raised into an erect or vertical posture, and folded together like those of most other palæozic crinoids. Indeed it seems difficult to conceive how an animal with so small a visceral cavity, could have been endowed with sufficient muscular and nervous force, to move such ponderous arms with any degree of facility. Hence it is probable that during the life of the animal, its arms were always extended out horizontally, and spread upon the same plane, like the rays of a fan. From all its known characters, we therefore regard it as the type of a distinct little group from the typical forms of *Cyathocrinus*, notwithstanding its agreement with that genus in the structure of the cup. For this group we would propose the name *Arachnocrinus*, from the spider-like appearance of the body and extended arms. In addition to the typical species *A. bulbosus*, it will doubtless include *A. pisiformis*=(*Poteriocrinus pisiformis*, Roemer), and some other Upper Silurian species.

In the August (1855) number of the Proceedings of the Philadelphia Academy of Natural Sciences, p. 159, we proposed the name Eupachycrinus, (*ευ*, well; *παχυς*, thick; *κρινον*, a lily), for the reception of a curious group, the type of which was figured by Mr. Lyon, in the Kentucky Geological report, vol. iii, pl. 1, figs. 2, 2 *a* and 2 *b*, under the name *Graphiocrinus* 14-*brachialis*. As little is known of the upper part of the body of this crinoid, it is difficult to determine whether it is more nearly allied to *Poteriocrinus*, or to *Cyathocrinus*. It differs from both, however, as well as from *Graphiocrinus*, in having its arms, from their origin on the first piece after the division on the second radial plate, composed of a double series of minute, very short, interlocking pieces, as well as in the remarkably solid, tumid character of its body pieces. For the present we place this group provisionally as a section of *Cyathocrinus*, though it is quite probable it will be found *generically* distinct both from that genus and *Poteriocrinus*. In addition to the typical species, it

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Note.—Since writing the above, a comparison of Mr. Lyon's figures of his *G.* 14-*brachialis*, in the Kentucky Report, with deKoninck's figures of his genus *Hydreionocrinus Woodianus* (*Bull. Acad. Royale de Belgique*, pl. ii), leads us to suspect that the Kentucky fossil, as well as the other species mentioned above, may possibly fall into Prof. deKoninck's genus. If so, of course the name *Hydreionocrinus* will have to take precedence over *Eupachycrinus*, and the group could not be placed as a subgenus under *Cyathocrinus*. Until more is known in regard to the upper parts of these American forms, however, this must remain an open question.

includes *E. pentalobus*=(*Cyathocrinus ? pentalobus*, Hall), and possibly, also, *Scophiocrinus orbicularis*, Hall, as well as our *Poteriocrinus* (*Scaphiocrinus*) *subtumidus*.

CYATHOCRINUS SCULPTILIS, Hall.

Pl. 15, Fig. 2*a*, 2*b*.

Cyathocrinus sculptilis, HALL, 1860. Supplement to Iowa Report, vol. 1, part ii, p. 59.

Cyathocrinus scitulus, MEEK and WORTHEN, Sept., 1860. Proceedings Acad. Nat. Sci., Philad., p. 393.

Cyathocrinus sculptilis (HALL), MEEK and WORTHEN, June, 1861. *Ibid*, p. 148.

BODY, below the summit of the first radial plates, basin-shaped, about twice as wide as high, truncated at the base, from which the sides expand rapidly upwards; composed of thick, strong, somewhat rugose plates, which are very convex in the middle and deeply excavated at the corners; sutures distinct. Base small, flat, or truncated on a plane with the under side of the subradials, so as not to be seen in a side view; columnar facet slightly concave, occupying apparently about two-thirds the area of the base, and perforated by a central opening equal to one-third its own diameter. Subradial pieces about as wide as long, directed obliquely outward and upward from the base; four of them pentagonal and one hexagonal, there being no visible angle at the middle of the under side in any of them. First radials much larger than the subradial pieces, about twice as wide as high, unequal, the two on the anal side being shorter than the others; all pentagonal, distinctly truncated and a little concave above, the upper side being much longer than either of the others; some of the superior lateral angles apparently a little truncated, as if for the reception of small interradial pieces. Anal piece about the size of the subradials, subquadrangular, widening from the base upwards. Height to summit of first radials, 0.36 inch; breadth, 0.71 inch; breadth of base, 0.23 inch; length of subradials, 0.21 inch; length of longest first radial, 0.23 inch; breadth of ditto, 0.33 inch.

The very prominent central portions of the subradial pieces are truncated below on a plane with the base, and project out horizontally from it in such a manner as to form a distinct five-rayed star, as seen from below. From near the middle of each subradial there is a rather obscure angular ridge, extending along each side of its prominent central portion to the base, and others connecting with similar ridges on the first radials and anal piece above. The very profound excavations between the prominent central portion of the subradials extend in so as to produce a slight emargination in the outer extremity of each basal piece, while the depressions between the first radials produce a similar indentation in the extremity of each subradial. Judging from the obliqueness of the superior truncated side of the first radial plates, it is manifest that the succeeding radials must have extended very obliquely outwards and upwards.

Prof. Hall's Supplement to the Iowa Report did not reach us until our description of this species, published in the Proceedings of the Academy of Sciences, was in type; and from the necessarily hurried manner in which we were then compelled to make comparisons, we overlooked the identity of the form under consideration with his *Cyathocrinus sculptilis*. The fact that he had described the first anal plate as being "heptagonal," and the second "quadrangular," with its "upper margin on a line with the summits of the adjacent radials," led us to think our specimen clearly distinct. A subsequent more careful comparison, however, with his diagram (page 60, Supplement to Iowa Report), has satisfied us that he had inadvertently described one of the subradial pieces as the first anal plate, and the first anal piece as the second. When these corrections are made in his description, it agrees so very nearly with our crinoid that we can scarcely entertain a doubt of their identity.

Locality and position: Burlington limestone, Burlington, Iowa.

GENUS POTERIOCRINUS, Miller.

Synon.—*Encrinus* and *Astropodia* (sp.), URE, 1793, Hist. Rutherglen.
Poteriocrinites, MILLER, 1821, Nat. Hist. Crinoidea, p. 68; Schlot., 1823, Naturg. Z. Petref. Th. 1, p. 82; Blainv., 1834, Man. Act., p. 260, and various others.
Poteriocrinus, AGASSIZ, 1834. Mem. Soc. Sci., Neuch., p. 197, and most subsequent authors.
? *Scaphiocrinus*, HALL, 1858. Iowa Report, vol. i, part ii, p. 550.
? *Cœliocrinus*, WHITE, 1863. Boston Jour. Nat. Hist., vol. vii, p. 499.

Generic formula.—
Basal pieces, 5.
Subradials, 5.
Radials, 1 (large) + 5, and a variable number of smaller ones.
Anals, 4 to 6.
Arms variously divided, according to the species.
Vault, greatly produced in the form of a large proboscis.

The body in this genus is usually obconical, with the five basal pieces united so as to form a more or less depressed pentagonal cup. Three of the five subradials are of the same form, and two on the anal side are more variable, and generally have each one or two sides more than the others. The five first radials are usually larger than the others, and connect with each other laterally, so as to form a part of the walls of the body; four of them are pentagonal, and alternate with the subradials, and the other generally hexagonal and often, though not always, raised with its summit above the others, while its base usually rests directly upon the upper truncated margin of one of the subradials.

The succeeding radial pieces vary in number, size and form in the various species, or even in the different rays of the same; there being sometimes as many as thirteen or more in one ray, and only from two to about five in the others. All of the radial pieces above the first series are free; or, in other words, those composing the different rays are not connected laterally, so as to form a part of the walls of the body. The anal pieces are somewhat irregular in their arrangement, but generally one of the first two rests between the superior sloping sides of the two irregular subradials, while the other is supported upon the truncated upper side of one of the subradial pieces; above these there are from two to four other anal pieces connected with the base of the proboscis.

The vault or summit of the body is enormously developed in the form of a great cylindrical, or ventricose trunk, generally at least as wide as, or in *Cœlocrinus* much wider than, the cup below, and nearly or quite as long as the arms, while its single opening is said to be located at its upper extremity.* De Koninck and Lehon think it was, in some species, merely protected by a soft integument, but in all the various species in which we have seen this part, it was composed of numerous small, very regular, close fitting, hexagonal plates, as in *Dendrocrinus* and some other allied genera. In *P. missouriensis*, Shumard, (*P. longidactylus*, Shumard, Missouri Report, pl. B, fig. 5), as well as several other species we have examined, including some of the *Scaphiocrinus* group, numerous slit-like pores are seen passing through the vertical zigzag sutures, between alternate ranges of these small pieces, so as to present much the appearance of the ambulacra of the Echinoids, excepting that these pores are not round, and do not pierce the pieces themselves, but pass through the sutures.

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* We follow Austin and others, in giving the upper extremity of the proboscis as the position of the opening of the summit, not having seen this opening in any of the specimens of this genus we have examined.

As already remarked, in connection with the description of that genus, the group under consideration is in some respects closely similar to *Cyathocrinus*, but differs remarkably in the size and structure of the superior parts of the body, as well as in some less important points of structure in the body below the arms. For all these differences see remarks on page 176. In the arrangement of the pieces of the body below the arms, it agrees almost exactly with *Hydreionocrinus*, de Koninck, though it differs completely above, in its arms being free, instead of united laterally so as to form a kind of cylindrical tube.

It is much more nearly allied to *Zeacrinus*, of Troost, from which it differs mainly in its larger and more protuberant base, more numerous and narrower radial pieces, as well as in the different form and proportions of its subradial and anal pieces. As *Zeacrinus*, however, in some of its species, approaches very nearly certain forms of *Scaphiocrinus*,* which seems not *generically* distinct from *Poteriocrinus*, it may be found that both *Scaphiocrinus* and *Zeacrinus* should be ranged as subgenera under *Poteriocrinus*.

If the type of *Graphiocrinus*, de Koninck and Lehon, should be found, as suggested by Mr. Lyon and Dr. Shumard, to have a series of five minute basal pieces within the range regarded as such by de Koninck and Lehon, which is highly probable, then it could not be distinguished, even subgenerically, from the typical species of *Scaphiocrinus*, in which case, the older name *Graphiocrinus* would replace *Scaphiocrinus*.

The groups *Scaphiocrinus*, Hall, and *Cœliocrinus*, White, as originally intended by their authors, appear to be sections or subgenera under *Poteriocrinus*. The first, *Scaphiocrinus*, as represented by the typical species, *S. simplex*, differs from *Poteriocrinus* proper, and approaches *Zeacrinus*, in having its base much smaller and less protuberant, and in being provided with but two primary radial pieces to each ray, while it also has but a single anal piece below the summit of the first radial pieces. Such are the gradations presented by other species, however, that Prof. Hall and others, who have recognized the group, have found it necessary to include species with a larger protuberant base, and with two anal pieces included in the wall of the cup below the top of the first radials.

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* It is acknowledged (Iowa Report, p. 682) that *Zeacrinus intermedius*, Hall, might with almost equal propriety be referred to either *Zeacrinus* or *Scaphiocrinus*.

So that the only distinction left would be the presence of but two primary radials to each ray, while Prof. Hall has referred some species possessing this latter character to *Poteriocrinus* proper.

The group *Cœliocrinus*, so far as known, seems to differ from *Scaphiocrinus* only in having the proboscis venticose or balloon-shaped above, instead of cylindrical, while it differs from the typical forms of *Poteriocrinus* both in that character and the presence of but two primary radial pieces in each ray. It is possible, however, that when the position of the opening of the summit is determined in *Cœliocrinus*, that it may be found to differ from that of *Poteriocrinus* proper. Dr. White thinks it must be situated near the base of the proboscis, as he could find no traces of it in specimens where all the upper parts of the proboscis were well preserved.

In accordance with the views of de Koninck and Lehon and other authors, we regard the genus *Poteriocrinus* as dating back at least to the Upper Silurian Epoch. Two English species have been referred to it from that horizon by de Koninck and Lehon (*Cyathocrinus goniodactylus*, and *C. capillaris*, Phillips); while *Homocrinus scoparius* of Hall (Palæont., N. Y., iii, pl. 1), certainly agrees with the typical forms of the genus far more nearly than the type of *Scaphiocrinus*, which Prof. Hall, and all others, place as a section of *Poteriocrinus*. In fact it seems to be in every respect a typical *Poteriocrinus*—whether we regard its general physiognomy, the form and structure of its proboscis, its rays or body, with the single slight exception of having the lower one of its two anal pieces, below the top of the first radials, isolated from those above the one connecting with its right superior sloping side. But if this very slight peculiarity of the lowest anal plate excludes this species from *Poteriocrinus*, how can that group include as one of its sections *Scaphiocrinus*, in the type of which this lowest anal plate is *entirely wanting*, and the whole physiognomy more widely different? Again, if this arrangement of the lowest anal plate excludes it from *Poteriocrinus*, how can it, upon such a basis of classification, be referred to *Homocrinus?*, the type of which (*H. parvus*) presents the marked difference of having the lowest anal piece resting directly down upon the basal pieces, to say nothing of the wide differences in the structure of the arms.

The genus *Poteriocrinus* also occurs in the Devonian rocks, both in this country and Europe. *P. minutus*, Roemer, is a European example; while Prof. Hall has described several species from the Hamilton division of the Devonian of this country. The so-called *Cyathocrinus ornatissimus*, Hall, from the Portage group of N. Y., is probably also a *Poteriocrinus*, judging from the figure.

It was during the Carboniferous epoch, however, that this genus undoubtedly attained its greatest development, and we have no evidence of its existence after the close of that period of our earth's history.

POTERIOCRINUS SWALLOVI, M. and W.

Pl. 16, Figs. 4*a*, 4*b*.

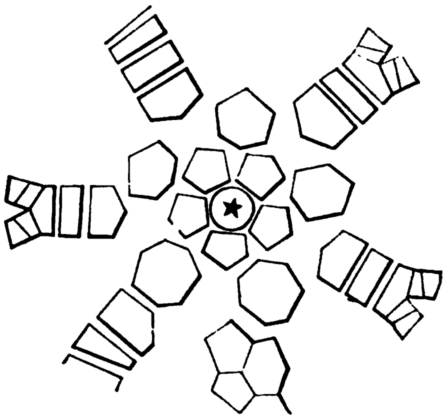
Poteriocrinus Swallovi, MEEK and WORTHEN, Sept. 1860. Proceed. Acad. Nat. Sci. Philad., p. 394.

BODY below the arms abconical, or tapering regularly down to its connection with the column; composed of smooth, nearly flat plates, connected by linear sutures. Base small, basin-shaped, truncate below, and widening gradually upwards, about half as high as wide, and composed of nearly equal pentagonal pieces; columnar facet comparatively large, a little concave, without a marginal rim, and pierced by a pentapetalous central opening, apparently less than one third the diameter of the column. Subradial plates unequal, some of them as long as wide, and others wider than long, three hexagonal, and two on the anal side, which are larger than the others, heptagonal. First radial plates smaller than the subradial pieces; all wider than high, pentagonal, and truncated above, the upper side being longer than either of the others. Second radials very short, about twice as wide as high, some of them somewhat wedge-shaped, or a little longer on one side than the other. Third radials short, or about twice as wide as high, four of them pentagonal and supporting the principal divisions of the arms on their superior sloping sides. In the anterior ray the third radial plate, instead of being a bifurcating piece, is truncated a little obliquely above, and succeeded by thirteen other radials; all of which, excepting the last, are very short, and alternately a little wedge-shaped; while the last one is larger than the others, pentagonal in form, and supports two divisions of the arms, similar to those in the other rays above the second bifurcation.

The first anal piece is pentagonal and rests between the upper sloping edges of two of the subradials, while its right superior sloping side supports one of the under sides of a first radial; and its left side connects with another anal piece, resting upon the truncated upper end of one of the sub-radial pieces. On the truncated upper margins of these two anal pieces two others are supported, but our specimen is not in a condition to show their form, or to enable us to determine whether or not they are succeeded by any other anal pieces above.

The arms are all long, robust and rounded, those of the two posterior, and the two lateral rays, after the first bifurcation on the third radial piece, bifurcate again on the ninth piece, beyond which they seem to be simple, and are each composed of a single series of short, somewhat wedge-shaped joints. The column is composed, near the body, of firmly anchylosed segments, the sutures of which are not visible 0.20 inch below its connection with the base. Its central cavity presents in a transverse section, the same pentapetalous form seen in the central perforation of the base. Length to summit of third radial pieces, 0.86 inch; breadth at the summit of the first radial pieces, about 0.60 inch.

Fig. 3.



Poteriocrinus Swallovi.
Diagram of body and rays to the bifurcation on the third radial pieces. Natural size.

This species seems to be more nearly allied to *Poteriocrinus missouriensis*, of Shumard, than to any other with which we are acquainted. It differs, however, in having a less gradually tapering body (though the specimen we have figured is compressed so as to give its body a broader appearance than is natural), and much stronger arms, which differ entirely in their mode of branching, as well as in the form of their segments. Our species has also a proportionally smaller column at its junction with the base. It was named in honor of Prof. G. C. Swallow, State Geologist of Kansas.

Locality and position: Same as preceding.

GENUS ZEACRINUS, Troost.

Synon.—*Cupressocrinus* (sp.), McCOY, 1849. Ann. Mag. Nat. Hist., 2d Ser., Vol. ii, p. 244; (not Goldf., 1832.)

Poteriocrinus (sp.), DE KONINCK and LEHON, 1854. Recherch. Crinoides, p. 91; and of some others.

Hydreionocrinus (sp.), DE KONINCK, 1858. Bull. Acad. Royale Belgique, 2d Ser., t. iii, p. 19.

Zeacrinus (TROOST), HALL, 1858. Iowa Report, Vol. i, part 2d, p. 541.

Generic formula.—

Basal pieces, 5, small, and often hidden by the column.
Subradials, 5.
Radials, 2+5, or often 3, 4 or more, in the anterior ray.
Anal pieces, 4 to 6 or more, visible between the arms.
Interradials, 0.
Arms, 10 to 40.

THE species embraced in this group have the body rounded below, with the five very small basal pieces sunken in a concavity, and often nearly or quite hidden by the column. The five* subradials are sometimes long, narrow, suboval or lanceolate, with a more or less pentagonal outline, excepting one on the anal side, which is often hexagonal. The primary radial series all alternate with the subradials, and are so wide as to connect laterally, so as to leave no spaces for interradial pieces; each consisting of two pieces, excepting in the anterior ray, which has usually three or more. Anal pieces, from four to six or more visible between the arms—two to three of them forming a part of the wall of the cup below the arms, as in *Poteriocrinus*. Summit unknown.

The species composing this group, although differing in general appearance, are closely related in structure to *Poteriocrinus*, but, as already stated in the remarks upon that genus (page 181), they differ in having the body rounded below, and the base very small and sunken; the arms are also usually less elongated and broader, as well as always with only two primary radial pieces, excepting in the anterior ray, which generally has more. Unfortunately we know nothing of the structure of the vault in this group, though judging from analogy, it was probably, as in *Poteriocrinus*, produced upwards as a large proboscis.

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* In one species (*Z. elegans*, Hall,) there is apparently an abnormal sixth subradial.

If the type of *Graphiocrinus*, de Koninck and Lehon, as suggested by Mr. Lyon and Dr. Shumard, should be found to have five minute basal pieces within the range described as basals by de Koninck and Lehon, it is not improbable that the group under consideration may be so connected with that type, through such forms as the typical species of *Scaphiocrinus*, that it will become necessary to unite the whole as members of one group. If so, de Koninck and Lehon's name would have to stand for the entire group, unless *Graphiocrinus* and *Zeacrinus* should both be regarded as forming distinct subgenera under *Poteriocrinus*.

So far as known to us, the *Zeacrinus* group is confined to the Carboniferous rocks; though Prof. Hall has described two species he refers to this genus from the Waverly Sandstone of Ohio, regarded by some as belonging to the Upper Devonian.

ZEACRINUS TROOSTANUS, M. and W.

Pl. 16, Fig. 2.

Zeacrinus Troostanus, MEEK and WORTHEN, September, 1860. Proceed. Acad. Nat. Sci., Philad., p. 390.

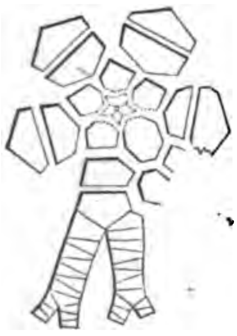
Zeacrinus scoparius, HALL, Feb., 1861. Descr. Crin. (Prelim. Notice, Albany), p. 8.

BODY depressed, basin-shaped below the arms, rounded and concave on the under side; composed of apparently smooth plates, which are connected by linear sutures. Base, small, concave, and nearly or quite hidden by the column. Subradial pieces unequal in size, a little wider than long, excepting the largest one on the anal side, four of them hexagonal, and one or two heptagonal, (counting three angles at the base). First radials nearly twice as wide as high, pentagonal, the superior horizontally truncated edge being longer than either of the inferior sloping sides. Second radials about the size of the first, wider than high, pentagonal, and indistinctly hexagonal; all longer on the inferior truncated side than either of the others; apparently four of them supporting on their superior sloping sides the first divisions of the arms, while the fifth on the anterior side is truncated above, and succeeded by three other very short, wide pieces, upon the last of which the first divisions of the arms rest.

Two of the anal pieces are visible in our specimen, resting upon the largest subradial, and apparently each supporting, or connecting with, one of the inferior lateral edges of a first radial on each side. It is of moderate size, pentagonal, and supports a smaller piece of unknown form, on its upper truncated side, while its left superior sloping edge connects with another small piece, apparently of a pentagonal form, resting upon a short truncated upper side of one of the subradials.

The arms are nearly flat, or but slightly rounded on the outer side, and bifurcate again after the first division on the second radial pieces (in the lateral and posterior rays), on the eighth, tenth and eleventh pieces; one of each of these divisions subdivides again on the twelfth or fourteenth piece, beyond which they all appear to be simple. The entire length of our specimen, to the extremity of the arms, is about 1.50 inches. Height of body, to summit of second radials, 0.20; breadth of do., at the top of second radial pieces, near 0.40 inch.

Fig. 4.



Zeacrinus Troostanus.
Somewhat enlarged.

This species is related to *Zeacrinus ramosus*, Hall, (Iowa Report, p. 549, pl. ix, fig. 3,) but differs in having its arms more flattened, and broader on the outer side. They also bifurcate less frequently, and the number of pieces between the bifurcations is considerably greater. Its second radials are likewise proportionally shorter, as are all the arm pieces. Again, all the divisions of its arms are given off much less obliquely than in *Z. ramosus*. The specific name was given in honor of Prof. G. Troost, deceased, former State Geologist of Tennessee, and the founder of the genus.

If *Zeacrinus* should be hereafter found to be synonymous with *Graphiocrinus*, as has been suggested, the name of this species would of course become *Graphiocrinus Troostanus*.

Locality and position: Burlington, Iowa, Burlington Limestone, of Lower Carboniferous series.

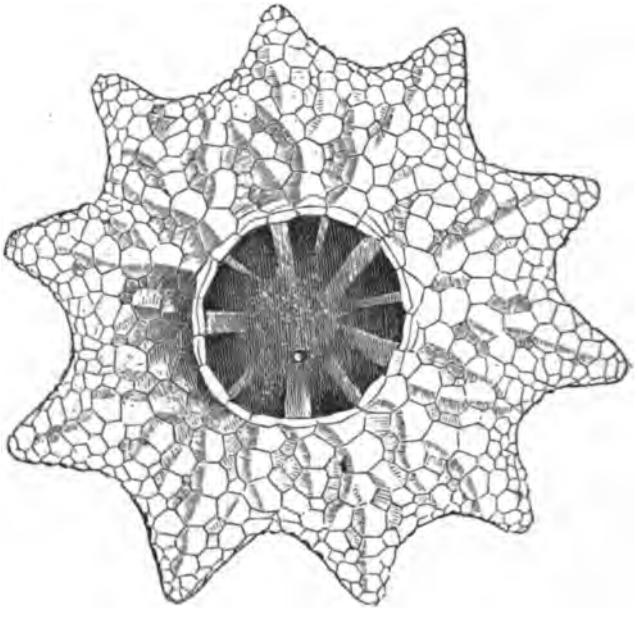
GENUS STROTOCRINUS, M. and W.

(στρωτος, spread; κρινον, a lily; in allusion to the spreading summit.)

Synon.—*Actinocrinus* (sp.), HALL; MEEK and WORTHEN, and others; (not MILLER.)
Calathocrinus, HALL (subgen. *Actinocr.*), Feb., 1861. Descr. Crinoid. Prelim. Notice, p. 12; (not von MEYER, 1848, Leonhard and Bronn's Jahrb., p. 469.)

Generic Formula.—
Basal plates, 3.
Subradials, 0.
Primary radials, 3+5.
Secondary ditto, 1 to 2+10, and succeeded by tertiary and other divisions, which, with the interaxillary, interbrachial and vault pieces, unite to form a greatly expanded, ten rayed, horizontal disc, completely isolating the anal and interradial areas from the vault, and supporting the free ascending arms around its margin.
Interradial pieces, 9 to 10, or more.
Anal pieces, 9 to 13, or more; the first one resting upon the basals.
Arms, 30 to 72, or more.

Fig. 5.



Strotocrinus perumbrosus?

This figure shows the expanded summit, natural size, as seen from below, with the body broken away—some portions of the outer margin of the disc being restored. The radiating bars seen within the central cavity are the partitions between the canals leading out to the rays. These canals are variously divided and subdivided in the expanded disc, before reaching the arm bases around the margins. The very small oral opening of the summit is seen a little below the middle.

THIS is another type, agreeing exactly with *Actinocrinus* in the number and arrangement of the pieces composing all that part of the body below the divisions of the rays. Above this, however, in the structure of the succeeding parts, to the bases of the free arms, it is remarkably different. After the first division of the rays, another bifurcation takes place on the secondary radials, and of the latter divisions the two outer usually consist of a succession of brachial pieces, while the two inner divisions continue on for some distance, sending off on each side alternating lateral division or ranges of brachial pieces, so as to produce a great number of arms. The spaces between all the divisions, out to the bases of the free arms, are occupied by small intermediate pieces, which, together with the brachial and other divisions, unite and spread out horizontally or at right angles to the axis of the body, so as to form an enormously expanded rim around the summit (see cuts No. 5 and 7), which isolates the anal and interradial areas from the vault, and bears the small, free, ascending arms around its margin. The vault is nearly flat, composed of numerous small pieces, and extends out to the farthest limits of the expanded summit, so that, as seen from above or below, it presents the appearance of a broad, flat, more or less distinctly ten-rayed disc. As in *Actinocrinus*, the arms are simple, and consist each of a double series of small, interlocking pieces. The body, below the expanded summit, in the species of this group, is more or less elongate-obconical, and usually somewhat truncated at the base (see cut No. 7, on p. 192), so that, with its greatly expanded summit and flattened vault, it presents a symmetrical, urn-shaped outline. The body plates are usually more or less costate, and sometimes beautifully rayed.

Like various other groups of palæozoic Crinoids, as the genera are now understood, the genus *Strotocrinus* includes two sections, distinguished as follows:

Section a.—The typical species, with a small, simple, subcentral opening in the vault without a projecting proboscis.

Including the typical species, *Strotocrinus perumbrosus* and *S. regalis*= (*Actinocrinus perumbrosus* and *A. regalis*, HALL).

Section b.—Species with a subcentral proboscis, bearing the opening at its upper extremity.

Strotocrinus erodus, *S. liratus*, *S. umbrosus*, *S. subumbrosus*, *S. ægilops* and *S. glyptus*=(*Actinocrinus* (*Calathocrinus*) *erodus*, *A. liratus*, etc. HALL),

The differences between the physiognomy of the species of this group, and that of the types upon which the genus *Actinocrinus* was founded, are so striking as to attract the attention of the most casual observer, and render their separation easy, even at a glance, where the entire body can be seen. We therefore regard them as forming a natural group, that should be separated generically from *Actinocrinus*,* particularly as it is now known that that group, as usually defined, would include a very large number of species in this country, presenting a great diversity of forms, and departing often widely from the original type in various ways. It has usually been the practice of naturalists to separate into distinct genera, upon less sharply defined characters, the species of a very large group, than would be done in cases where the species are less numerous. Although this may not, in all cases, be philosophical, it is certainly convenient, and is, as we believe in the present instance, required by a correct classification of these extinct forms.

Accustomed, as palæontologists have most generally been, to distinguish the genera of crinoids almost entirely by the number and arrangement of the pieces composing that part of the body below the arm-bases, without regard in many cases to the most marked differences in other parts, it is not probable that the genus under consideration will be at once generally accepted, but that the propriety of such a separation will be ultimately admitted, we have no doubt.

The transition from this genus to *Actinocrinus*, is through some sections of the *Batocrinus* group, as we have defined it; and in some cases, where the margin of the expanded summit has been evenly broken away, as represented in the figures of *Strotocrinus* (*Actinocrinus*) *umbrosus*, Hall, in the Iowa Report, pl. 11, these forms might be confounded generically with such species of the *Batocrinus* group as *Actinocrinus æqualis*, Hall, represented by fig. 4 of the same plate. It will be observed, however, that even in this case there are characters by which these types can be distinguished by a careful observer.

In the first place, the species of the group under consideration, always have the body below the horizon of the arms, more elongated in proportion to the height of the vault than in *Batocrinus*. Again, in *Batocrinus* the body plates are scarcely ever marked with radiating costæ, as we usually see in *Strotocrinus*. Another readily observed distinction is, that in the *Batocrinus* group the second primary radial pieces, are almost, if not quite, invariably quadrangular, and generally wider than high, instead of hexagonal, as in *Strotocrinus*. This latter character may seem to be one of little importance, but when we remember that it is coexistent with the other distinctions, it becomes of more significance than it would otherwise be. Where the specimens of *Strotocrinus* have the margins of the expanded summit entire, they will be at once distinguished from any known examples of *Batocrinus*, or the other type of the *Actinocrinidæ*.

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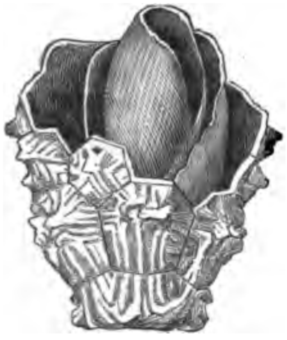
* Prof. Hall first proposed to separate this type as a subgenus under *Actinocrinus*, but used for it the preoccupied name *Calathocrinus*.

Fig. 6.



Strotocrinus regalis.

Showing a part of the body, with the expanded summit, and a part of the side removed in order to exhibit the involuted internal organ connected with the digestive apparatus.

As is known to be the case in several species of *Actinocrinus*, *Agaricocrinus*, etc., some species at least, of *Strotocrinus*, were provided with a peculiar, convoluted internal plate, resembling the shell of a *Bulla*, or *Scaphander*, placed with its longer axis so as to coincide with that of the body of the crinoid. The annexed cut represents this organ as it occurs in its natural position, in a broken specimen apparently of *S. regalis*,=(*Actinocrinus regalis*, Hall). As seen in the specimen, however, it is thickly coated with small crystals of carbonate of lime, not represented in the cut.

Prof. Hall mentions seeing a similar plate in *S. erodus*=(*Actinocrinus erodus*, Hall), as well as in species of *Agaricocrinus* (Decr. new sp. *Crinoidea*, Prelim. Notice, p. 12, 1861), but makes no suggestions in regard to its nature or probable use in the internal economy of these animals.* We have likewise seen this organ in *Actinocrinus rotundatus*, Yandall and Shumard, and have little doubt but it existed in all the *Actinocrinidæ*, and possibly other families of palæozoic crinoids. We regard it as corresponding to the spongy axis and spiral plate around which the digestive canal in *Comatula europæa* passes, (see Muller's figures of this axis and plate in *Abandl. Akad. Wissinsch*, *Prelim.*, 1841, *pl.* 5). It differs, however, in being a simple plate rolled up somewhat like a scroll of parchment, or the shell of a *Scaphander*, instead of being wound around a spongy axis like the thread of a screw. The discovery of such an organ in these older types of *Crinoidea*, is of much interest, since it seems to settle the question in regard to their having been provided with an internal digestive apparatus, as in the living types—a fact that has been recently questioned by Dujardin and Hupe, who appear to think they were nourished by absorption over the whole external surface.

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* Since the foregoing remarks were written, and the accompanying cut prepared, we observe Prof. Hall has published in the March number of the Am. Jour. Sci., vol. xli, p. 261, 1866, a note, in which he mentions seeing this plate in *Actinocrinus longirostris*, *A. pentagonus*, *A. Verneuilii*, and some of the forms we have included in *Strotocrinus*, and states that on showing one of the specimens to Prof. Agassiz, he remarked that he had seen a similar organ in *Comatula.*

So far as known to us, this group is confined to the horizon of the Burlington limestone of the Subcarboniferous series, and unless *Actinocrinus costus*, of McCoy, from the Carboniferous rocks of Ireland, may possess the expanded summit of this genus, it would seem to be peculiar to America.

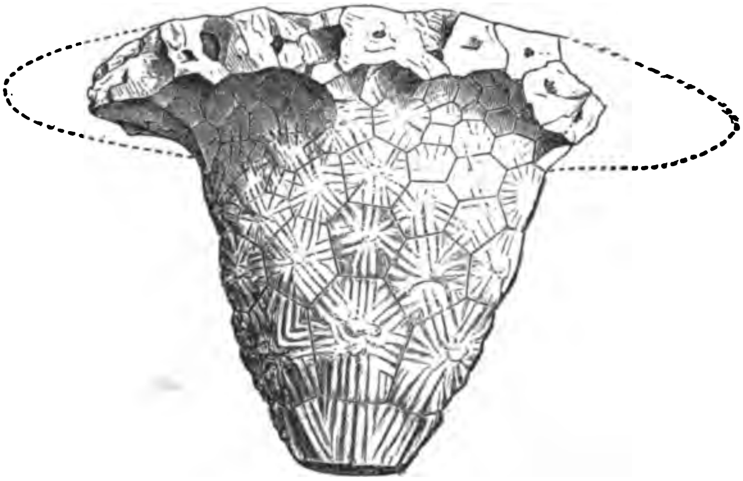
STROTOCRINUS REGALIS, (sp.) Hall.

Pl. 16, figs. 6*a*, 6*b*, and following cut.

Actinocrinus regalis, HALL, 1860. Sup. Iowa Report, p. 8.

Actinocrinus speciosus, MEEK and WORTHEN, Sept. 1860. Proceed. Acad. Nat. Sci. Philad., p. 386.

Fig. 7.



Strotocrinus regalis.—(Nat. size.)

Side view, showing the body with part of the expanded summit broken away. When entire, the expanded summit extended out at least as far as indicated by the dotted lines.

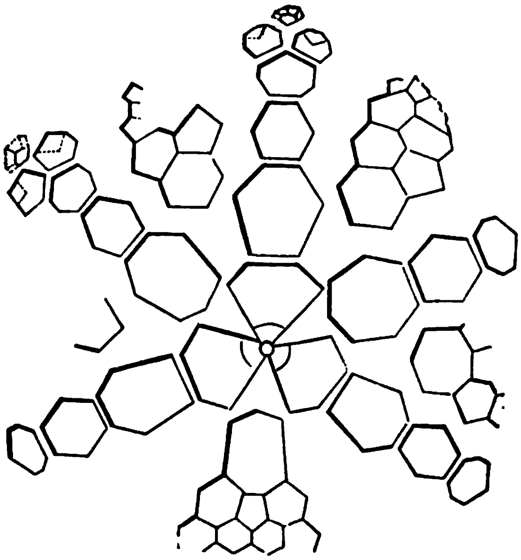
BODY attaining a large size, elongate obconic below the horizon of the arms; composed of moderately convex, ornately costate plates, which are joined by more or less impressed sutures. Base, cup or basin-shaped, twice as wide as high, truncated below, for the reception of the column, and expanding moderately upwards—composed of regular, subequal, hexagonal plates, with broadly and deeply grooved sutures; facet for the reception of the end of the column flat, rather large, or nearly half as broad as the summit of the base, marked by radiating striæ, and provided with a small, scarcely projecting rim, which is not interrupted by the sutures—perforated by a nearly round, central opening, near one third the diameter of the head of the column. First radial plates large, the posterior ones being smaller, and proportionally narrower than the others; all generally longer than wide; three of them hexagonal, and two heptagonal. Second radials, rather smaller than the first, about as wide as long, all hexagonal. Third radials, rather smaller than the second, generally a little wider than long, heptagonal in form, and each supporting on its superior sloping sides, two smaller heptagonal or octagonal secondary radials, which appear to have been each surmounted by two tertiary radials, or possibly in part, brachials. Resting between the superior sloping sides of the third radials, is a small hexagonal, interaxillary piece, evidently surmounted by others, the number and forms of which are unknown.

First anal plate nearly as long as the first radial on each side of it, but narrower and distinctly smaller than the anterior first radial, heptagonal in form, and surmounted by two much smaller hexagonal, and one pentagonal pieces in the second range; in the third range there are four still smaller pieces, and above these others, the number, form and arrangement of which cannot be determined in the specimens described. First interradial plates each nearly or quite as large as the second radials, hexagonal or heptagonal in form, and surmounted by two or three smaller pieces; above the latter there are apparently about three other ranges of two pieces each, which is as far as our specimen shows them.

The surface of the plates is neatly ornamented by narrow, sharply elevated ribs, about four to six of which radiate from the central region of each plate, to each of its sides, excepting below the middle of the first radials, where there are usually about eight or ten. The costæ on the other plates are less numerous in proportion to the size of each, and like those on the first radials, extend to the sides—those crossing any one side being all arranged parallel to each other, so as to form with those on the adjacent plates, a series of concentric, equilateral triangles. Sometimes these costæ are, on the upper plates, notched or more or less irregularly interrupted, while on some of the upper interradial plates they show a tendency to become broken up into little, spine-like projections. Height (on the anterior side) to the summit of the third radials, 1.89 inch; breadth at the top of the third radials, 1.65 inch; breadth of base, 0.84 to 0.90 inch; height of do., 0.46 inch.

The foregoing characters were given by us from a specimen from which the summit and all the parts above the first secondary radial pieces, are broken away. We had compared it carefully with a weathered specimen returned by Prof Hall, with the name *A. regalis* attached, and as our specimen not only presents some differences in the details of its sculpturing, but differs in having three instead of two plates in its second range of anal pieces; thus giving a heptagonal instead of a hexagonal form to its first anal piece; while it also has a greater number of pieces in the third and fourth ranges of the anal series, and has the interradial spaces so drawn inwards above as to apparently indicate that it had not the summit dilated above, as in *A. regalis*, we supposed it to be distinct, and described it under the name *A. speciosus*. Since publishing our description, however, we have had, through the kindness of Mr. Charles Wachsmuth, of Burlington, an opportunity to examine a fine specimen (see fig. 7, p. 192) agreeing almost exactly in form, general appearance, and the sculpturing of its plates, with our crinoid, and yet showing clearly that it has the dilated summit, and structure of the upper parts seen in *A. regalis*.

Fig. 8.



Strotocrinus regalis.

About half natural size. Made out from the specimen figured on plate 16, figure 6.

Hence we can scarcely doubt that these specimens both really belong to the species described by Prof. Hall, with which Mr. Wachsmuth's specimen also agrees in the number and arrangement of its anal and interradial pieces.

Mr. Wachsmuth's specimen shows it to be a noble species, attaining a length from the base to the summit of the vault, of 2.50 inches; while its dilated summit, must have measured, when entire, nearly 3 inches in breadth, and that of the body just below, about 1.80 inches. Its vault is almost perfectly flat, and seems to be provided with a small, nearly central opening. The number of free arms must be very great, though no specimens we have seen are sufficiently well preserved to show their exact number. Prof. Hall says there are seventy-two in the entire series.

As may be seen from our figures, this species closely resembles in form, and the arrangement of its plates, as well as in its surface markings, a species described by Prof. McCoy, under the name *A. costus*, from the Carboniferous rocks of Ireland, (*Synop. Carb. Foss. Ireland, pl.* 26, *fig.* 2). It is rather more attenuate, however, and has a more protuberant and more truncated base, while it is very improbable that the Irish species (the upper part of which is unknown) has the dilated summit of the group to which the American form belongs; at any rate no European species showing the characters of that type, has yet, so far as our knowledge extends, ever been found.

Locality and position: Burlington, Iowa; Burlington limestone, of the Subcarboniferous series.

GENUS STEGANOCRINUS, M. and W.

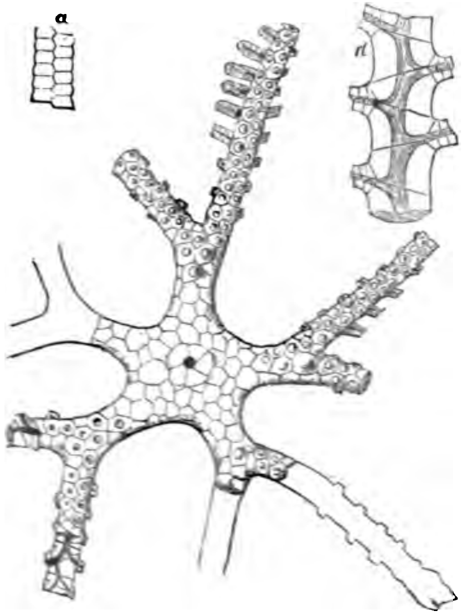
(*στεγανος*, covered; *κρινον*, a lily; in allusion to the covered free rays.)

Synon.—Actinocrinus (sp.), HALL, 1858. Iowa Report, vol. i, part 2d, p. 577 and 582; Meek and Worthen, Sept., 1860. Proceed. Acad. Nat. Sci., Philad., p. 387; (not Miller, 1821.)

Generic Formula.—

Basal plates, 3.
Subradials, 0.
Radials, 3 + 5.
Interradials, 3 to 6 (or more?) + 4.
Anals, 3 to 10 or more.
Rays, from the third primary radial pieces, forming greatly produced, free, arm-like appendages, either bifurcating or simple, which are covered, their entire length above, by small plates, and provided on each side with a row of alternating true arms. Vault, with a subcentral proboscis.

Fig. 9.

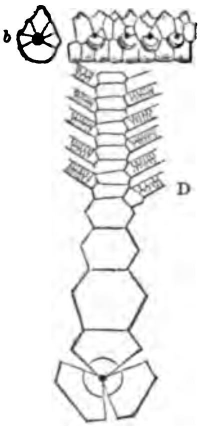


Steganocrinus pentagonus (natural size).

This cut shows the upper side of the body and the covered free rays, with portions of the true arms as given off on each side of the rays. Fig. *a* is an enlargement of one of the true arms, as seen on the under side. Fig. *d* shows the structure of the free rays, as seen from above, with the small covering plates removed, so as to expose the internal cavity, with its branches extending out to the true arm-bases, alternately arranged on each side. The base of the proboscis, and its opening, are seen near the centre of the body.

From the foregoing formula it will be seen that this type agrees exactly with *Actinocrinus* in the number and arrangement of the pieces composing the body, as far as to the third radial pieces, but differs remarkably in the structure of its rays beyond. These rays, as may be seen by the annexed figure 9, extend out horizontally to a great length, in the form of tubular, free, rigid, arm-like appendages, covered all the way out with small pieces like those of the vault; while they are composed on the under side of a single range of pieces (see *d*, fig. 9), strongly curved up on each side, and giving off alternately on either side the true ascending arms, composed each of a double series of small alternating pieces, bearing the tentacles. These long, free, arm-like rays, sometimes bifurcate on the third radial pieces, while in other instances they are simple, being composed of a series of very gradually diminishing pieces, the first of which scarcely differs from the third radial, upon the truncated upper side of which it rests, or from those following, all of which are in a direct line with the primary radials of the body. Hence in these instances there might be said to be an indefinite number of radial pieces to each ray.

Fig. 10.



Steganocrinus sculptus.

Cut showing the base and part of one of the rays (D), with the arm-base on each side; *a* represents a part of the free ray, with its arm-bases and covering plates, as seen in a side view; and *b* represents a transverse section of the same.

The annexed cut will show the structure of one of these simple rays in *S. sculptus*,=(*Act. sculptus*, Hall). Of their entire length we cannot speak positively, as they are incomplete in all the specimens we have seen. In one instance, however, one of them is seen to extend 1.53 inches from the body, or nearly three times the breadth across the body below the rays, at which point it is broken off. Where the pieces covering these arm-like rays have been removed, the cavity within is seen to be very slender, and slightly flexuous at the points where the true arms are given off, exactly as in the rays of the typical species *S. pentagonus*, as seen in fig. *d*, of cut 9, on the opposite page. As much as they resemble arms, we can but regard them as really extraordinary extensions of the body, and the little tentacle-bearing appendages on each side as the true arms.

In some instances the first brachial piece, at the base of the first true arm in *S. sculptus*, is larger in one of the rays, than represented in the annexed cut, and presents somewhat the appearance of their being a bifurcation on the third radial, but it is easy to see that there is not a true bifurcation, but that the radial series continue directly on, giving off arms alternately on each side. Of course Prof. Hall was mistaken in describing this species as having only *three* arms to each ray.

The vault in the known species of this type terminates in a subcentral proboscis, and the visceral cavity is provided (at least in the typical species (*A. pentagonus* of Hall), with a spiral Bulla-like organ, as in other types of the *Actinocrinidæ*.

Of course we do not expect those palæontologists who insist upon including in the same genus all the species of crinoids that agree in the number and arrangement of the pieces composing the body, without regard to the most extraordinary differences in the other parts, will adopt this genus. Believing as we do, however, that the whole combination of characters presented by the entire structure of these animals should be taken into consideration in their classification, we can but regard the differences between this type and the typical forms of *Actinocrinus* as being of generic importance.

At present we know of but three species that can be with any degree of confidence referred to this group. These are the typical species, *S. pentagonus*=(*Actinocrinus pentagonus*, Hall), *S. sculptus*=(*Act. sculptus*, Hall), and our *S. araneolus*, first described by us as *Actinocrinus araneolus*. We have little doubt, however, but several other species referred to the genus *Actinocrinus*, from our Carboniferous rocks, will be found to belong here.

So far as known, this group is confined to the Subcarboniferous rocks of America.

STEGANOCRINUS ARANEOLUS, M. and W.

Pl. 15, Fig. 1 *a*, 1 *b*.

Actinocrinus araneolus, MEEK and WORTHEN, Sept., 1860. Proceed. Acad. Nat. Sci., Philad., p. 387.

BODY small, much depressed, stelliform as seen from above and below, in consequence of the deeply excavated character of the interradial spaces; composed of obscurely granulose plates, which are more or less distinctly costate and angular on the under side of the body. Base small, flat, and subhexagonal; columnar facet round and nearly flat. First radial plates extending out horizontally on a plane with the base, strongly convex and angular in the middle, from which a more or less prominent angular ridge radiates to each of the sides; all slightly broader than long, and hexagonal or heptagonal, the central angle at the base of the latter being very obtuse. Second radial pieces nearly as large as the first, wider than long, distinctly curved upwards at each side, and more or less convex in the middle, from which an obscure angle sometimes extends to the side, connecting with the base, and one to each of the lateral margins, presenting a hexagonal outline as seen from below, but possessing an additional angle on each side, only seen in a lateral view. Third radials of the same size as the second, from which they project out horizontally; strongly curved upwards at the sides to connect with the small vault pieces extending out over each ray; pentagonal in outline, as seen from beneath, but having an additional angle on each side not visible from below.

Third primary radials supporting on each of their outer sloping sides the divisions of the free rays, only the bases of which we have seen attached to any of the specimens yet found, though from the fact that the rays are free from the second radials, and covered above by small vault pieces, it is evident the species belongs to the group *Steganocrinus.*

First anal plate near two-thirds as large as the first radials, hexagonal in form, and supporting two smaller hexagonal pieces in the next range. Above these there are three or four others in the third range, but they belong, perhaps, nearly as much to the vault as to the anal series, though they generally connect with the second, and partly with the third, primary radials on each side.

First interradials about two-thirds as large as the first radial pieces. They are a little longer than wide, regularly hexagonal, and support on their superior sloping sides two smaller pieces, which connect with the vault.

The summit is depressed, and composed of small, somewhat irregular pieces, which are more or less convex, while some of those extending out over the free rays, between the body and the bifurcation, rise into little conical nodes like those covering the free divisions of the rays beyond. The subcentral proboscis is slender, rises abruptly from the depressed vault, and is near the base, composed of very prominent plates, which probably form short spines farther up. The costæ on the body plates are mainly formed by the deep excavation of the corners of these pieces, so as to leave a ridge extending from the middle to each side of the same. Breadth of the body of the largest specimen, measuring across between the rays, 0.45 inch; height of ditto, 0.32 inch; breadth of free rays before bifurcation, 0.14 inch; breadth of the divisions of ditto, at the base, 0.10 inch; breadth of proboscis at base, 0.17 inch.

This species is most nearly allied to *S. pentagonus*, but will be readily distinguished by its smaller size and much more depressed form. This difference of form is most obvious in a side view, its base being truncated so as not to be seen projecting beyond the subradials, upon which the body rests when placed on a plane surface in its natural attitude.

Locality and position: Burlington limestone, of the Subcarboniferous series, Burlington, Iowa.

GENUS ACTINOCRINUS, Miller, 1821 (page 147).

ACTINOCRINUS CONCINNUS, Shumard.

Pl. 15, Figs. 9*a*, 9*b*.

Actinocrinus concinnus, SHUMARD, 1855. Missouri Report, plate A, figure 5.

Actinocrinus validus, MEEK and WORTHEN, Sept., 1860. Proceedings Acad. Nat. Sci., Philad., p. 384.

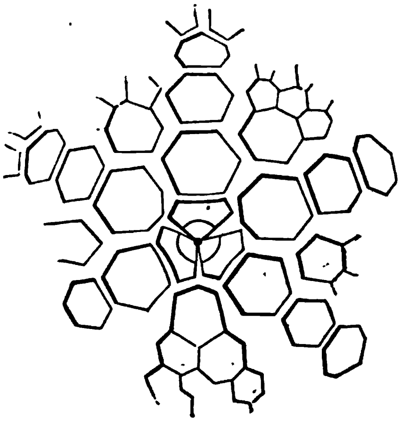
BODY of medium size, subglobose in form, exclusive of the third radial and secondary radial pieces, the summit being more depressed than the cup below the arms. Calyx beneath the top of the second radial plates, somewhat rounded on the sides, and composed of thick, convex, radiately costate plates, connected by moderately distinct sutures. Summit composed of smaller irregular tuberculose pieces, and provided with a nearly central proboscis; anal and interradial spaces deeply sinuous. Base small, truncated and slightly concave below, about four times as wide as high, not provided with a continuous marginal rim, composed of nearly equal plates, with deeply grooved sutures between; columnar facet nearly two thirds as broad as the base, concave and marked by fine, radiating striæ. First radial plates generally a little wider than high, two of them hexagonal, and three heptagonal, the angle at the middle of the lower side in the latter being obtuse. Second radials a little wider than long, hexagonal, about one-half to two-thirds as large as the first radial plates, and ranging a little more obliquely outwards. Third radial pieces smaller than the second, from which they extend out almost horizontally; crenate transversely, their lateral extremities curving up to connect with the vault pieces extending out over the rays, heptagonal in form, and each supporting on its outer sloping sides, one or two secondary radials, which also project out horizontally.

The first anal piece is nearly as large as the first radials, about as wide as long, hexagonal in form, and supports on its superior sloping sides two smaller pieces, one of which is hexagonal, and one heptagonal; above these there are in the next range four smaller pieces, which connect with the vault pieces above. The first interradial plates are about the size of the second radials, as long as wide, hexagonal and heptagonal, and support two or three smaller pieces in the next range.

Of the distinct radiating costæ on the first radial plates, from three to four pass across to the sides by which they are connected together, and from each to the base, while one or two extend to the margins connecting with the second radials, and first interradials above. The third radials are somewhat constricted at their connection with the second radial pieces, and more or less tumid above, but have no distinct costæ. Height to top of third radial plates, about 0.65 inch; do. to top of vault, near 0.95 inch; breadth of body between the rays, 0.90 to 1 inch; breadth of base, from 0.42 to 0.45 inch; height of do., 0.12 inch.

This species is somewhat allied to *A. stellaris*, de Koninck and Lehon (*Recheaches sur les Crinoides, Belgique*, pl. 3 and 4), but has a more depressed summit, and more convex sides below the arms; while its first and second radial plates, and first interradials, are larger and more convex, as well as much more strongly

Fig. 11.



Actinocrinus concinnus—(Near nat. size).

costate.* Another difference of still greater importance is, that in the species now under consideration the third radial pieces project so strongly outwards, and the anal and interradial spaces are so deeply sinuous, that these pieces (as seen from below) appear connected with the body by the inner margin only; while in authentic specimens of *A. stellaris*, from Belgium, now before us, they are so deeply implanted between the second range of interradials, as to be scarcely visible from below. Again, in *A. stellaris*, there is but one secondary radial between the first and second bifurcations of each ray, while in the American species there are two.

Locality and position: Cedar creek, Warren county, Illinois; Burlington limestone, of the Subcarboniferous series.

ACTINOCRINUS SCITULUS, M. and W.

Pl. 15, Fig. 7*a* and 7*b*.

Actinocrinus scitulus, MEEK and WORTHEN, Sept., 1860. Proceedings Acad. Nat. Sci., Philad., p. 386.

A. rusticus, HALL, Feb., 1861. Descrip. Crinoidea (Prelim. notice), p. 2; Boston Jour. Nat. Hist., vol. vii, p. 267.

Compare *A. Sillimani*, M. and W., June, 1861. Proc. Acad. Nat. Sci., Philad., p. 134.

BODY rather under medium size, more or less nearly urn-shaped, the summit being depressed-convex, and the calyx below the arms abconical, with a truncated, slightly expanded base; sides expanding regularly from the base to the third radials, above which the secondary radial and first brachial pieces extend out horizontally, leaving excavated anal and interradial spaces between the clusters of arms. Base of moderate size, more than twice as wide as high, truncated and concave below, where it is as wide as at the summit, and projects below the end of the column; margins so deeply notched at the sutures as to present a distinctly trilobate appearance as seen from below; columnar facet round, about one-third as wide as the base, and provided with a minute central perforation. First radial pieces a little wider than long, two of them heptagonal and three hexagonal, widening from the base to the lateral angles, and each provided with a prominent, compressed, central node, extending somewhat obliquely outwards and downwards, from which one or two rather angular ridges pass down upon the basal plates. Second radial pieces between one-half and two-thirds as large as the first, distinctly convex, or each having a more or less distinct central node, about one-third wider than high; two of them pentagonal and three hexagonal. Third radials as wide as, or wider than, the second, but rather shorter, three pentagonal and two heptagonal, supporting on each of their superior sloping sides a smaller secondary radial piece, each of which is surmounted by two smaller pieces, which, if they are both brachials, would make four arms to each ray, or twenty in all; but there are some appearances of another bifurcation on each inner piece, which would make thirty arms.

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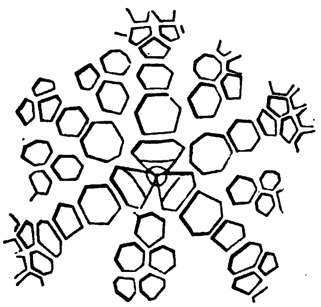
* We should remark here, that the Belgian specimens of *A. stellaris*, with which we are making the comparison, are more strongly ribbed than those figured by de Koninck and Lehon, and far more nearly like the American form under consideration.

The first interradial pieces are about as large as the second radials, and, like them, are each provided with a central node. They are as long as wide, regularly hexagonal, and support on their superior sloping sides two smaller pieces in the second range, and two or three in the third, which connect with the vault above and with the brachial pieces on each side. The first anal plate is sometimes nearly as large as the first radials, hexagonal in form, and supports in the second range, two rather smaller hexagonal or heptagonal pieces; above these there are two others, which connect with the third radials and secondary radials on each side, and with the vault above.

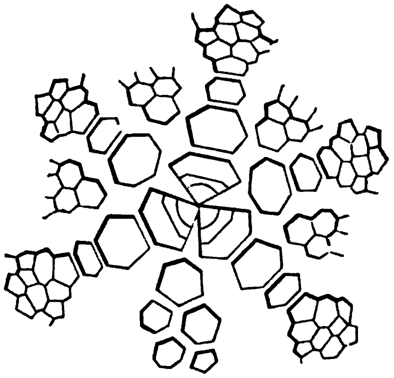
The summit is composed of irregular, convex pieces, of various forms, and provided with a slender, subcentral proboscis, rising rather abruptly from its surface. Height to summit of vault, 0.66 inch; do. to top of third radials on the anterior side, about 0.50 inch. Breadth of base, 0.35; height of do., 0.14 inch. Breadth across the summit, between the rays, 0.61 inch.

Fig. 12.



Actinocrinus scitulus. (Natural size.)
Diagram showing the anatomy out to the second divisions of the rays.

Fig. 13.



A. Sillimani. (Enlarged two diameters.)
Cut showing the anatomy of this form, for comparison with *A. scitulus.* The specimen being in a better condition, shows the secondary and Tertiary radials more satisfactorily.

This species is nearly related to *A. verrucosus*, Hall (*Iowa Report, vol.* 1, *part* 2, *pl.* 10, *fig.* 7), but differs in having its summit much more depressed, and composed of less tumid plates, while its proboscis is more slender, and rises more abruptly from the vault. It also differs in having but five, instead of seven or eight, anal pieces below the horizon of the arms, and the nodes on its body plates are more prominent, and of different form. It is true most of these peculiarities are of a kind, in which individuals of the same species in this genus sometimes vary to a greater or less extent, but in the depression of its vault, and the less tumid character of the pieces composing it, as well as in the slenderness of its proboscis, the individuals of the form under consideration vary but little, and are readily distinguished from *A. verrucosus.*

On comparing this species with Prof. Hall's description of his *A. rusticus*, and with specimens identified with it by Mr. Wachmuth, of Burlington, Iowa, we have scarcely a doubt of their identity. Farther comparisons of additional specimens, since describing our *A. Sillimani*, have also nearly convinced us that the latter was likewise founded upon a variety of this variable species. The type of *A. Sillimani* has the body and base more depressed, and the nodes on its body plates much more prominent; it also differs in having a distinct rib passing up each of the rays, and their subdivision, out to the arm-bases, and in the forms of some of the pieces. These characters give this crinoid a very distinct aspect, but the structure being essentially the same, we are led, since seeing several specimens showing various intermediate gradations in these characters, to regard these forms as probably belonging to the same species.

We had not seen Prof. Hall's description of *A. rusticus* * until after our diagnosis of *A. Sillimani* was printed, or we should certainly have observed its exact agreement with the type of the latter.

Locality and position: Upper part Burlington limestone, of Subcarboniferous series, Burlington, Iowa.

SUBGENUS BATOCRINUS, Casseday. (See p. 150.)

SECTION D.

ACTINOCRINUS DODECADACTYLUS, M. and W.

Pl. 15, fig. 3 *a*, 3 *b*, 3 *c*.

Actinocrinus dodecadactylus, MEEK and WORTHEN, June, 1861. Proceed. Acad. Nat. Sci., Philad., p. 131.

BODY rather small, subglobose; summit and calyx below the arms, of nearly the same size; breadth a little greater than the height; composed of slightly convex, smooth or subgranulose plates, which are connected by moderately distinct sutures. Base small, much depressed or subdiscoidal, obtusely hexagonal in outline, with three other obtuse, retreating angles at the sutures. First radial plates wider than long; three of them regularly hexagonal, and two heptagonal. Second radial pieces much smaller than the first, about twice as wide as long, and all quadrangular. Third radials a little longer than the second, all regularly hexagonal, the two inferior lateral margins being very short, and the two superior sides each about equaling the base. In the two posterior rays the third radial pieces each support, on one of their superior sloping sides, a large brachial piece, and on the other a secondary radial of near the same size, which in its turn supports two brachial pieces, making three arms to each of these rays; while in all the others two brachial pieces rest directly upon the third radial, thus making only twelve arms in the whole series.

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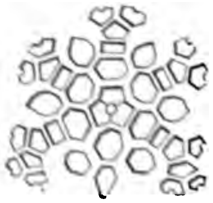
* We of course allude here to his description published in the Boston Journal Nat. Hist., vol. vii, p. 269, and not to his very brief preliminary notice of three lines, published in some sheets issued at Albany in Feb., 1861, in which the formula of the arms was said to be, "as far as known, four to each ray."

The first anal plate is about as wide as the first radials, but a little longer, being longer than wide, instead of the reverse. It is regularly heptagonal, and supports on each superior lateral sloping side, a smaller heptagonal piece; while an elongated, coffin-shaped piece rests upon its short, superior, truncated side between the two latter, and extends up, flanked on either side by the first brachials, to the summit. Each of the interradial spaces is filled by a single, ovate, octagonal piece, about as large as the second and third radial pieces taken together.

The vault is composed of rather large, somewhat regularly arranged plates, which are very nearly flat, the smaller ones all being on the anal side; the proboscis is small, and located nearer the anal than the dorsal side. Height to base of proboscis, 0.50 inch; breadth, 0-58 inch; breadth of base, 0.23 inch.

Fig. 14.



Actinocrinus dodecadactylus—(Natural size).

This symmetrical little species is so nearly like *A. rotundus*, of Shumard (*Geol. Report Missouri*, *p.* 191, *pl. A*, *fig.* 2, 2*a*, 2*b*), that it might readily be confounded with it, although it is clearly distinct. In the first place it is less distinctly rotund than that species, while it differs in being entirely destitute of secondary radials, excepting a single one on one of the sloping sides of the third radial piece in each posterior ray; while in *A. rotundus* there are two of these pieces, one upon the top of the other, resting upon the superior sloping sides of each third radial. This difference in the arrangement of the parts gives twenty arms in Shumard's species, while in ours there are only twelve. Again, our species has but a single interradial piece in each space, while in *A. rotundus* there are from two to three. The anal pieces are likewise more numerous in Shumard's species than in ours, while its plates are more flattened, and its sutures less distinct.

Knowing that the number of arms sometimes varies to some extent, in different specimens of the same species of crinoids, we were at first inclined to think the form under consideration might be only a young specimen of *A. rotundus*, but on comparing it carefully with specimens of that species of the same size, we find they possess the usual number of arms (20) in all our specimens, and uniformly present the other differences mentioned.

Locality and position: Same as preceding.

ACTINOCRINUS ASTERISCUS, M. and W.

Fig. 15, fig. 8*a*, 8*b* and 8*c*.

Actinocrinus asteriscus, MEEK and WORTHEN, Sept., 1860. Proceedings Acad. Nat. Sci., Philad., p. 385.

Actinocrinus æquibrachiatus, var. *alatus*, HALL, Jany., 1861. Boston Jour. Nat. Hist., vol. vii, p. 263.

Compare *A. æquibrachiatus*, MCCHESNEY, Jany., 1860. New Palæozoic Fossils, from Western States, p. 25.

BODY rather under medium size, much depressed, the under side being somewhat more convex than the vault; stelliform as seen from below or above, in consequence of the excavation of the interradial spaces; sides expanding rapidly and curving outward, so as to bring the third radials, secondary radials and first brachial pieces all upon a horizontal plane; plates rather thin, apparently subgranulose, flattened, and separated by close fitting sutures. Base small, rounded and destitute of a distinct marginal rim, two and a half to three times as wide as high. First radial plates wider than long, three of them hexagonal and two heptagonal, the angle at the middle of the base of the latter being very obtuse. Second radials small, about twice as wide as high, pentagonal and hexagonal. Third radials somewhat larger than the second, pentagonal or occasionally hexagonal, about twice as wide as high, and each supporting on its superior (or more properly outer) sloping sides, two secondary radials; these are each succeeded by another, which in its turn supports two of the brachial pieces, making in all four arms to each ray, or twenty in the entire series.

The first anal plate is a little smaller than the first radials, heptagonal in form, and supports three smaller pieces in the next range, two of which are hexagonal and one heptagonal; above these there are two other still smaller pieces, and over the latter, in the fourth range, three large arcuate plates, connecting with the vault above. The first interradial pieces are of moderate size, as long as wide, hexagonal, and each supporting two smaller pieces in the next range; above the latter there are two or three larger, alongate pieces in the third range, which arch inwards and connect with the summit.

The vault is depressed, composed of numerous medium sized convex pieces, and provided with a subcentral proboscis. The arms are all broken from our specimens, but judging from the size of the openings, they would appear to be very slender. They seem to have ascended vertically from the upper side of the second brachial pieces. Height to the base of the proboscis, about 0.50 inch; ditto to arm openings, 0.35 inch; breadth across from side to side, between the interradials, 0.67 inch; greatest breadth across between the arm openings on opposite sides, 0.93 inch.

This form is thought to be a variety of *A. æquibrachiatus* of McChesney, in which opinion we are inclined to concur, since seeing Prof. McChesney's figures, recently published. As we have not yet seen specimens showing *all* the intermediate gradations, however, connecting these two forms, although we have several of each before us, we are not fully satisfied that we should consider them identical. They are certainly very similar, there being no difference of specific importance in the structure or arrangement of the parts composing the body. The differences that must distinguish them, either as species or varieties, are the more depressed and distinctly lobed form of the *asteriscus*, the interradial and anal spaces being excavated nearly half way in from the arm bases towards the center, so as to give the body a very distinctly five-lobed outline, instead of having merely slightly sinuous margins, as seen from above or below. It will also be seen, from our figures, that even the axillary and interbrachial spaces in our crinoid are also somewhat sinuous, while the lobes formed by its arm bases are more flattened, and its base more rounded, than in the *æquibrachiatus*. At the same time that we are prepared to believe our form may prove to be only a variety of *A. æquibrachiatus*, it is certainly more distinct from that species than *A. inornatus* of Hall is. So that if we unite *A. asteriscus* and *A. æquibrachiatus*, we would apparently have to include *A. inornatus* also. To one unacquainted with the imperceptible gradations by which such an extremely divergent form as this is connected with the *Batocrinus* group, it would seem like an unnatural arrangement to include it; yet it is so connected as not to be separable more than specifically from others that shade into the typical forms of *Batocrinus.*

Locality and position: Upper part of Burlington limestone, Lower Carboniferous series, Burlington, Iowa.

GENUS AMPHORACRINUS, Austin.

Synon.—*Melocrinites* (sp.), GOLDF. Nov. Act., vol. xix, p. 341; (not in Petref., vol. i, p. 197, 1826).
Amphora (sp.), CUMBERLAND, 1826. Reliquiæ Conservatæ, p. 36.
Actinocrinus (sp.), PORTLOCK, 1843. Report Geol. Lond., p. 347, and of various others; (not Miller, 1821).
Melocrinus (sp.), BRONN, 1848. Index, p. 719.
Amphoracrinus, AUSTIN, 1848. Quart. Jour. Geol. Soc., Lond., vol. iv, p. 292; (not Roemer, 1852. Bronn's Leth. Geog., vol. ii, p. 250, tab. iv, fig. 15).
Dorycrinus, ROEMER, 1853. Wiegm. Arch., p. 207.

THE generic formula of this group is precisely that of *Actinocrinus*, with perhaps the exception of more generally having a small number of anal and interradial pieces. It is distinguished from that genus, however, by having the opening of the summit lateral, directed outwards, and penetrating a thickened protuberance composed of small pieces. In some instances the opening is not much more lateral than in particular examples of section (*c*) of the true *Actinocrinus* group, which consists of species without a proboscis; but even in these cases it still differs in being directed outwards, or in being placed upon, or rather penetrating, a protuberance, which usually extends down the anal side, so as to separate the two posterior rays more widely than the others; while the arm-bases are nearly always more in groups, and more protuberant than in that section of *Actinocrinus*. Again, the species of *Amphoracrinus* are usually distinguished from the typical forms of *Actinocrinus* in generally having the second primary radial pieces quadrangular, instead of hexagonal, and the body plates, with very rare exceptions, without radiating costæ. In the latter characters they agree with the *Batocrinus* group, from which, however, they are readily distinguished by their lateral opening without a proboscis, as well as by nearly always having their arm-bases and the adjacent parts forming five protuberant lobes. They likewise differ from all sections of *Actinocrinus*, as we understand that genus, in having the vault very frequently armed with one or more strong, sometimes greatly elongated spines.

Of all the types included as subgenera, under *Actinocrinus*, by those who give the widest limits to that genus, the *Amphoracrinus* group is most nearly allied to *Agaricocrinus* and *Megistocrinus*, which we exclude from *Actinocrinus*, and regard as most probably forming two separate and distinct genera from each other, as well as from that under consideration. That they both, however, (particularly the former) so closely approach *Amphoracrinus*, through a few intermediate forms, as to be sometimes with difficulty distinguished, is no less true than that very nearly all the known species can be readily separated into these three groups. The chief distinctions between *Agaricocrinus* and *Amphoracrinus* consist in the more depressed form of the body and the concavity of the under side of the former, by which its arm-bases are brought down upon a horizon with the lowest part of the body. The arms in this group are also stouter, and if we mistake not, invariably consist of only two to each ray; while in *Amphoracrinus* there are often three in each of the posterior rays, and sometimes three or four to each ray all around. Again, we know of no species of *Agaricocrinus* that has the vault provided with elongated spines, as we often see in the *Amphoracrinus* group. The transition from one to the other of these types is through such forms as *Actinocrinus planobasalis*, *A. brevis*, *A. corniculus* and *Agaricocrinus pentagonus*, Hall.

The *Megistocrinus* group seems to us to preserve its integrity as a genus more decidedly than *Agaricocrinus*, although not differing always so widely, in general appearance, from certain species of *Amphoracrinus* as the typical forms of *Agaricocrinus* do. Still, even these forms, approaching most nearly *Amphoracrinus*, differ in their more broadly rounded under side* and more depressed summit, while their opening *never* (as in *Amphoracrinus* and *Agaricocrinus*) *penetrates a thickened protuberance, but in all the known species presents the appearance of an abruptly projecting proboscis.* We have never seen a specimen with this proboscis entire, or indeed retaining more than its base; but this base always shows thin, prominent, fractured edges, and in the typical Carboniferous species, at least, is situated lower on the side than the opening of *Amphoracrinus* or *Agaricocrinus*, being upon a line with, or even sometimes a little below, the horizon of the arm-bases. Another difference, that may seem of little importance, is nevertheless a constant one: that is, the second primary radial pieces in *Megistocrinus* are always hexagonal instead of quadrangular, as is most generally the case in *Agaricocrinus* and *Amphoracrinus*. Again, *Megistocrinus* always differs from *Agaricocrinus* in having the body much more prominent below the arm-bases, and the vault proportionally more depressed.

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* We doubt the propriety of including in *Megistocrinus* those remarkable Devonian species, with the under side broadly and abruptly truncated, and the vault provided with a stout, nearly central proboscis, described by Mr. Lyon under the names *M. Knappii* and *M. spinosulus*. Nor can we agree with our friends Prof. Winchell and Prof. Marcy in referring to this genus the elongated, obconic, Upper Silurian species described by them under the names *M. Marcouanus* and *M. infelix*, which belong to *Saccocrinus*, Hall.

The three species that have been supposed to show a complete transition from *Megistocrinus*, through such forms as *Actinocrinus unicornis*, into the *Amphoracrinus* group, *i. e.*, *Actinocrinus brevicornis*, *A. minor* and *A. superlatus*, Hall (the types of the last two of which are now before us), seem to us to be true *Megistocrinus*. They have exactly the form and physiognomy of that genus, with which they agree in all points of structure not probably due to age, and in having all their second radial pieces hexagonal instead of quadrangular; while the typical specimens of the species *A. minor* and *A. superlatus* show that the opening is placed on the side slightly lower than the arm-bases, and instead of being surrounded by a thickened protuberance, presents abruptly projecting, fractured, thin edges, like the base of a small lateral proboscis, precisely as we see in the typical species of *Megistocrinus*. It is also worthy of note that Prof. Hall describes the other species (*A. brevicornis*) as having a "proboscidiform aperture." Hence we regard these three forms as true *Megistocrinus*, and probably young individuals.

We are not sure the genus *Amphoracrinus* commenced its existence as far back as during the Upper Silurian epoch, though some Hamilton group (Devonian) species described in New York seem to belong to it. It was during the deposition of the Subcarboniferous rocks, however, that it attained its maximum development, and became extinct.

The law of priority would, perhaps, compel us to adopt Cumberland's name, *Amphora*, for this genus, were it not for the fact, that the species he evidently regarded as the typical one was a true *Actinocrinus*. Cumberland gave no generic description, but figured and described two species under the name *Aphora*. He used no specific names, but numbered the species "1st species" and "2d species." His first species, in the text, is the second on the plates. Of the first species, he says (p. 37) "the plates of this fine specimen, which is entirely hollow, are remarkably emarginated with broad borders, resembling, on its outer form, an earthen wine *Amphora*, with five handles for suspension and a central neck to pour from." Hence it is evident the name was suggested by this first species; and as it is a true *Actinocrinus*, *Amphora* becomes merely a synonym of that genus, as it is, *in part*, of *Amphoracrinus* of Austin, to which group his second and only other species belongs.

AMPHORACRINUS SUBTURBINATUS, M. and W.

Pl. 15, Fig. 4 *a*, 4 *b*.

Actinocrinus (*Amphoracrinus*) *subturbinatus*, MEEK and WORTHEN, Sept., 1860. Proceed. Acad. Nat. Sci., Philad., p. 388.

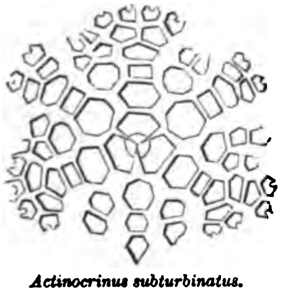
BODY rather under medium size, turbinate or obconical below the arms, and depressed convex above; expanding regularly with straight sides from the column to the summit of the third radials, thence more abruptly to the arms; composed of flat, smooth or merely granulose plates, which are connected by close-fitting sutures. Interradial and anal spaces rather distinctly sinuous between the groups of arms. Base comparatively small, subpentagonal, about one-third as wide as high, and not provided with a projecting rim; columnar facet small, concave, less than half as broad as the base. First radial plates generally a little wider than long, widening from the base to the lateral angles, two of them heptagonal and three hexagonal. Second radials small, about twice as wide as long, quadrangular, or rarely with one of the upper angles slightly truncated, so as to produce a fifth angle. Third radial pieces a little larger than the second, about twice as wide as high, hexagonal and heptagonal, and supporting on each superior sloping side, in the anterior and posterior rays, one small secondary radial piece, each of which gives rise to two first brachial pieces, while in each of the two antero-lateral rays, the two small secondary pieces are truncated above, and each surmounted by a single brachial piece; making two arms to each of these rays, and four to each of the others, or sixteen to the entire series.

The first interradial plates are about two-thirds as large as the first radials, nearly or quite as long as wide, and six to eight sided. On the superior sloping sides of these, rest two smaller pieces, which partly support the secondary radials, and are surmounted by two or three irregular pieces, which extend up between the brachial pieces and connect with the vault. The first anal plate is about as large as the first radials, as long as wide, heptagonal in form, and surmounted by three smaller hexagonal pieces in the second range, the middle one of which projects above the others. Surmounting these, there are three pieces in the third range, the two lateral of which each supports an irregular piece above, while the middle one projects considerably above the others, in a wedge-shaped point, and bears on its superior sloping sides a series of protuberant pieces surrounding the small anal aperture, which opens laterally a little above the horizon of the arm openings.

The summit is depressed and composed of unequal, irregular pieces, one of which over each of the rays, and another near the middle, are usually larger than the others, and appears to have been tumid, or may even have been extended into short spines, so as to place it in *Dorycrinus*, if that name is to be retained for a section of this genus. Height to top of vault, 0.59 inch; breadth across the summit between the groups of arms, about 0.60 inch; do. from the arm openings on opposite sides, 0.73 inch.

This species bears some resemblance to *A.* [*Amphoracrinus*] *trinodus*, of Hall, but has the base less truncated, the vault more flattened on top, and provided with six nodes or spines, instead of three; while it has four arms instead of three to each posterior ray, and four instead of two in the anterior. Its most marked characters are its short, obconical, or turbinate form below the arms, and truncated dome. The latter rises somewhat abruptly above the arms, as much as about one-third of the height of the cup below these, but is abruptly flattened on top, so as to give it a truncated appearance. Our specimen is not in a condition to enable us to determine whether or not the summit had spines, though some remains of the larger piece over each ray, seem to indicate that they were, when entire, quite prominent. The sinuosities between the rays gives the body a pentalobate outline as seen from below.

Fig. 15.



Actinocrinus subturbinatus.
(Near natural size.)

Locality and position: Same as preceding.

GENUS CŒLOCRINUS, M. and W.

(*ϰοιλος*, hollow; *ϰρινον*, a lily; in allusion to the concave base.)

Sphærocrinus, MEEK and WORTHEN, 1865. Proceed. Acad. Nat. Sci., Philad., p. 154; (not Roemer.)
Cœlocrinus, MEEK and WORTHEN, 1865. Ib., p. 273; (not *Cœliocrinus*, White, 1863.*)

IN this type the formula is that of such species of *Actinocrinus* as have no secondary radials, and but few anal and interradial pieces, excepting that it has its opening lateral, as in *Amphoracrinus* and *Agaricocrinus*, while its base is concave, as in the latter genus. From *Agaricocrinus*, with which it perhaps most nearly agrees, it differs in having greatly less robust arms, which come out around the summit, instead of on the horizon of the lower part of the body. It also differs in having its first anal and first radial pieces curved up so as to form nearly half the height of the lateral walls, as well as under, so as to form most of the under side of the body. From *Amphoracrinus* it differs in the sunken character of its base, the concavity of the under side, and the curved character of its first anal and first radial pieces, as well as in having weaker arms, and its arm-bases not projecting—there being but a single brachial piece to each division of each ray, soldered into the walls of the body, and these rest directly upon the third radials. The small lateral opening of the summit is on the same horizon as the arms, and rather in a slight depression than upon a protuberance, as we usually see in *Amphoracrinus* and *Agaricocrinus*.

It is possible that we should place this as a subgenus, either under *Agaricocrinus* or *Amphoracrinus*, though we are at present inclined to regard it as being distinct from both.

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* Some have objected to the name *Cœlocrinus*, because it is thought to be too near *Cœliocrinus*, of White, previously used for another type. As Dr. White's name, however, was derived from the Greek for *the belly*, and the two names are otherwise quite as distinct as many others retained in various departments of natural history, we cannot admit the force of this objection.

We know but the single typical species, which is from the Subcarboniferous series.

CŒLOCRINUS CONCAVUS, M. and W.

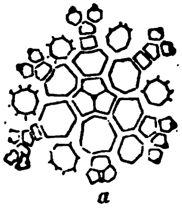
Pl. 15, Fig. 10 *a*, 10 *b*, 10 *c*.

Actinocrinus (*Amphoracrinus?*) *concavus*, MEEK and WORTHEN, June, 1861. Proceed. Acad. Nat. Sci., Philad., p. 132.

Actinocrinus (*Sphærocrinus*) *concavus*, M. and W., Aug., 1865. Ib., p. 154.

Actinocrinus (*Cœlocrinus*) *concavus*, M. and W., Dec., 1865. Ib., p. 273.

Fig. 16.



Cœlocrinus concavus, (Natural size.)

This cut shows the structure of the body out to the brachial pieces inclusive, with the position of the minute lateral anal opening at *a*.

BODY small, subglobose, broader than high, a little oblique; summit nearly flat; under side rounded and distinctly concave; sides rising vertically, or nearly so. Surface smooth, or subgranulose. Base small, concave, and entirely included within the concavity of the under side. First radial plates comparatively large, convex, and curving under so as to form a part of the concavity below; two of them heptagonal and three hexagonal. Second radial pieces wanting in two of the rays (of the specimen before us); in the others small, wider than long, and quadrangular in form. Third radial pieces smaller than the second (in three of the rays), pentagonal in form, and each supporting upon their superior sloping sides the first brachial pieces, which form a part of the walls of the body. First interradial pieces comparatively large, or about one-half the size of the first radial plates, nine sided, the superior sloping sides of each supporting one side of two of the brachial pieces, while two very small pieces rest upon the middle of the summit, and connect with the vault above, and with the brachial pieces on each side. First anal piece a little larger than the first radials, heptagonal in form, and supporting in the next range three pieces, the two lateral of which are larger than the other, and connect above, on their sloping sides, with brachial pieces, while the middle piece between these is irregularly hexagonal, and supports three very small pieces in the next range, which connect with the anal opening and the vault pieces above, and with the brachials on each side.

Vault made up of a few comparatively large pieces, the central one of which is a little more convex than the others. Anal opening very small, lateral, or on about the same horizon as the arm openings, and surrounded by only five plates, which are not protuberant. Arm openings twelve, small, arranged around the margin of the summit, three to each of the two posterior rays, and two to each of the others. Arms apparently, from the small size of the openings, and the very small articulating surfaces for the first free arm pieces, very slender and fragile. Column unknown. Height of body, 0.31 inch; breadth from the anal to the anterior side, 0.42 inch; breadth of base, 0.17 inch.

In the concavity of the under side, and the incurved character of its first anal and first radial pieces, this species presents much the appearance of a *Zeacrinus*, though in the number and arrangement of the parts composing the whole body, it will be seen to possess all the essential characters of the great genus *Actinocrinus*, as it has been generally understood. We placed it provisionally in the subgenus *Amphoracrinus*, in first describing it, on account of the lateral position of the anal opening, but we subsequently became satisfied that it differs sufficiently from the species of that group to be made the type of a distinct genus. It differs from *Agaricocrinus* in having comparatively much larger first radial pieces, and very differently formed and arranged interradials, as well as in the general form of its body, and its much weaker arms, which are also located around the summit, instead of around the lower part of the body.

We are under obligations to Mr. Charles Wachsmuth, of Burlington, Iowa, for the use of the only specimen of this species we have seen.

Locality and position: Burlington, Iowa; Burlington limestone, of the Lower Carboniferous series.

GENUS GILBERTSOCRINUS, Phillips.

Synon.—*Ollacrinus*, CUMBERLAND, 1826. Appendix to Reliquiæ Conservatæ (without generic or specific diagnosis or specific name.)

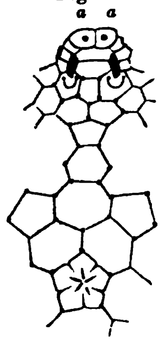
Gilbertsocrinus, PHILLIPS, 1836. Geol. Yorkshire, part ii, p. 207.

Rhodocrinus (part), DE KONINCK and LEHON, 1854. Recherch. sur les Crinoides, p. 104; and of several other authors; (not Miller, 1821).

Goniasteroidocrinus, LYON and CASSEDAY, 1859. Am. Jour. Sci. Vol. xxviii, (2) p. 232.

Trematocrinus, HALL, 1860. Sup. Iowa Report, p. 70.

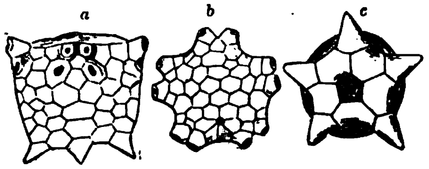
Fig. 17.



Gilbertsocrinus bursa.

This cut shows one of the rays with the base of its false arms, *a*, *a*, and nearly under these the true arm openings. From *Phillips's Geol. Yorks*, ii, pl. iv.

Fig. 18.



Gilbertsocrinus calcaratus, Phillips.

The above cuts are from Cumberland's *Reliquiæ conservatæ*, where this species is figured under the name of *Ollacrinus*. Fig. *a*, side view, shows the bases of false arms and the openings below for the attachment of the true arms, which latter he wrongly represented as if penetrating directly through the plates instead of passing between them. Fig. *b* represents the vault with its opening, and the false arm bases. Fig. *c* represents the under side, but does not show the divisions of the base.

PHILLIPS's diagnosis of this genus reads as follows:

"Basal joints five, forming a pentagon; suprabasal [subradials] five, hexagonal, forming a decagon, with five re-entering angles, from which proceed five heptagonal first costals [first radials], and five hexagonal second costals [second radials], bearing a pentagonal scapula [third radial], supporting joints [secondary radials], which combine into rounded arms, perforated in the centre. First intercostals [first interradials] pentagonal. The following species have been usually referred to *Rhodocrinus*, Miller, from which, it appears to me, they differ entirely."

He mentions but the following three species, viz: *G. calcaratus*, *G. mammillaris* and *G. bursa*, all from the Subcarboniferous. His generic and specific descriptions are very brief and unsatisfactory, but his figures are tolerably good, and give a sufficiently intelligible idea of the generic characters of the group.

From these figures and his description, with what is now known of several American species of this type, it is evident that the formula, in accordance with the later improved nomenclature, may be stated as follows:

Generic formula.—

Basal pieces, 5.
Subradials, 5.
Radials, 3+5.
Secondary or supraradials, 3 or 4+10.
Anal and interradial pieces, 12 to 15+5.
Pseudo-brachial appendages (arms of some authors), 5, or rarely 6 (from the division of one on the anal side); located over or between the rays.
Arm-openings (ambulacral) 10, located directly under the pseudo-brachial appendages, or alternating with them.

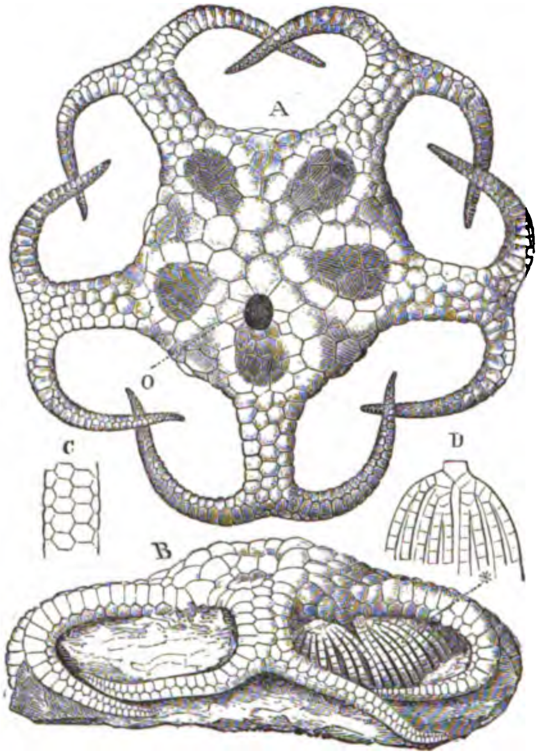
The genus may therefore be characterized thus: body usually short subcylindrical. Base small, formed of five pentagonal pieces, composing a more or less impressed pentagonal disc. Subradials five, alternating with the basal pieces, all hexagonal or obscurely heptagonal, and truncated above for the reception of the first anal and first interradial pieces; like the first radials, often protuberant or extended in the form of spines. Primary radials in five series, of three each, and all alternating with the subradials; the first one of each series heptagonal, the second hexagonal and the third hexagonal or heptagonal, and supporting on its superior sloping sides the diverging secondary radials. Of the latter, there are two or three in each range, the last one of which supports on its inner sloping sides the delicate pendent arms; while in one section of the genus, the outer sloping side of each of these pieces bears another piece, which, owing to the divergence of the secondary radials, meets the corresponding piece of each adjacent ray (excepting rarely on the anal side) over the interradial and anal spaces, and there forms the base of the stout false arms, which, in the typical species of the group, stand over the interradial and anal spaces. Interradial and anal areas oval, often scarcely distinguishable from each other, and usually nearly or quite isolated from the vault above; each occupied by from ten to seventeen or eighteen pieces. Interaxillary or interbrachial spaces occupied by from two to eight or ten small pieces, the upper of which connect with the false arm-bases and vault. True arms very long, slender, pendulous, and more or less branching, supporting minute ascending tentacula. Pseudo-brachial appendages five, or rarely six (from the division of the one on the anal side), composed of two ranges of pieces, with a central cavity in those of each range, or of several ranges inclosing a double central cavity; not furrowed above or provided with any external openings; all extending out from the margins of the dome, at first horizontally, and then bifurcating—the divisions spreading, curving downwards, and each tapering to a point. Vault much depressed, with usually a more or less marked concavity opposite each false arm; opening sublateral, or about midway between the centre and margin of the dome, not raised upon a proboscis.

This interesting group, as here defined, includes two sections, distinguished as follows:

1. **GILBERTSOCRINUS,** Phillips (proper).=*Ollacrinus,* Cumberland.
   Pseudo-brachial appendages located directly over the interbrachial spaces; anal and interradial pieces not quite isolated from the dome.
   Examples: G. calcaratus, G. bursa and *G. mammillaris,* Phillips.—(European.)
2. **GONIASTEROIDOCRINUS,** Lyon and Casseday,=*Trematocrinus,* Hall.
   Pseudo-brachial appendages located over the interradial and anal areas, which (excepting sometimes the latter) are entirely separated from the dome.
   Examples: G. tuberosus, Lyon and Casseday; *G. fiscellus,* M. and W., and *G. papillatus, G. reticulatus, G. typus,* etc., published by Prof. Hall under the name *Trematocrinus.*—(American.)

From the foregoing description, it will be seen this genus agrees almost exactly, in the structure of the body below the arms, with *Rhodocrinus,* Miller, with which it is often confounded. It was, indeed, if we mistake not, also originally separated from that group by Phillips, under a misapprehension in regard to the number of basal pieces in *Rhodocrinus,* which had been described as having a tripartite base. After this error in regard to the structure of *Rhodocrinus* had been pointed out, by Austin and others, it is not at all surprising that nearly all who had only seen the specimens of *Gilbertsocrinus* figured by Phillips, divested of the appendages of the upper part of the body, should have regarded it as synonymous with *Rhodocrinus.* The following cut however, of the upper part of *Goniasteroidocrinus tuberosus* of Lyon and Casseday, with its appendages, (in which it evidently agrees with *Gilbertsocrinus*, excepting in their larger size and position over the interradial spaces), will show, as we believe, sufficiently important differences to separate this type entirely from the genus *Rhodocrinus* proper.

Fig. 19.



Goniasteroidocrinus tuberosus.

Figure *A* represents the upper side of the vault, with the opening (*O*) and the pseudo-brachial appendages. One of these appendages and one of the divisions, in part, of another, are restored; they are all likewise somewhat more regularly curved than in the specimen. Fig. *B* represents a side view of the same specimen, with the lower part of the body hidden in the matrix. The false arms are here represented as curved in the specimen. The asterisk (*) designates the connection of the small, true, pendent arms with the body, as they are seen between two of the false arms. *C* represents the structure of the under side of the false arms, between the body and the bifurcation; and *D* is an enlargment of the bases of the true arms as near as can be made out.

From these figures, it will be seen that this type differs so widely from *Rhodocrinus*, in the structure and arrangement of the appendages of the upper part of its body, that the parts supposed by Phillips and others to be the arms, in *Gilbertsocrinus*, are really not homologous with the arms of *Rhodocrinus*, nor indeed, in any proper sense, arms at all, as that term is used in describing crinoids, but are, on the contrary, curious additional appendages, composed of two or more ranges of pieces; and although provided with a central cavity through nearly their entire length, connecting with the cavity of the body, they have *no open ambulacral furrow above*, nor indeed any traces whatever of an external opening. Consequently they are not only not arms, but differ entirely from all the appendages of the body in any other known crinoid, and seem to bear somewhat the same relations to the body that the side branches of the column of *Pentacrinus* and many palæozoic crinoids do to the column itself. In addition to this, the parts in this type homologous with the arms in *Rhodocrinus* and other crinoids, instead of being stout and erect, as in *Rhodocrinus*, are very slender, long, pendent organs (see * of cut B, fig. 19), having much the delicacy and appearance of tentacles.

In the above cut, the minute true arms of the typical species of *Goniasteroidocrinus*, are seen to branch so as to form nine to each ray. The cut shows only their outside, in which we have seen no indications of ambulacral furrows; but these may have been obliterated in cleaning the specimen, or possibly they may present the anomalous character of being on the *under side*, and thus differ from those of all other known crinoids. As far as these arms can be traced near the base, they are each composed of a single series of minute pieces, but according to Mr. Lyon, they are farther down, composed each of a double series of minute interlocking pieces.

These true arms connect with the body at the openings that suggested to Prof. Hall the later name *Trematocrinus* for this group. Such differences as these, in the parts connected with the reproductive, and perhaps the respiratory organs, should surely separate this type from *Rhodocrinus*.

But as these organs have not yet been seen entire, in the typical European species of the genus *Gilbertsocrinus*, it may be argued that we have no right to conclude that the *Goniasteroidocrinus* group is congeneric with Phillips's genus. We think, however, that any one who will take the trouble to compare the foregoing cuts of *Goniasteroidocrinus tuberosus* and our figure of *G. fiscellus*, on pl. 15, fig. 5, together with the other American species described by Prof. Hall under the name *Trematocrinus*, with Phillips's figures of his typical species of *Gilbertsocrinus*, and particularly with Cumberland's figures of one of the same species, which we have reproduced for comparison, on page 217, will agree with us that these European species must have had these organs, with the slight difference of relative position already mentioned, exactly as in *Goniasteroidocrinus*.* Nor can we believe the difference in the position of the false arms, with relation to the true ones, alluded to above, of more than subgeneric importance.

The fact that Cumberland had, in 1826, proposed the name *Ollacrinus* for Phillips's typical species, leaves us in some doubt whether we should not adopt his name for the genus, in accordance with the rules of priority. The reasons for doubting the propriety of adopting his name are not only that he gave no diagnosis or description either of his typical species or of the genus *Ollacrinus*, and merely published figures on a separate supplementary plate, with the name *Ollacrinus* printed upon it, but in addition to this he did not, in his little work, consistently follow the binomial system of nomenclature. Some of his names are binomial, it is true, while in other instances he has such names as "*Mitra rugoso quinque perforata*," "Genus *Sitularia triangulariformis*," etc. Hence the rule of priority should probably not be regarded as applicable in his case.

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* It is due to Mr. Billings that we should state here, that so far as we know, he was the first author who called attention to these two sets of appendages in *Gilbertsocrinus bursa*, Phillips (*Decade iii, Canadian Organic Remains, p.* 25 *and* 26), though, owing to the fact that he had never seen an entire specimen, he there seems to have regarded this as the structure of *Rhodocrinus*. We are gratified to be able to state, however, that he now fully concurs with us in the opinion that *Gilbertsocrinus* is distinct from *Rhodocrinus* proper.

The proposed genus *Acanthocrinus* of Roemer, seems to be related to *Gilbertsocrinus*, but if we have correctly understood the arrangement of the arms of the former, it is distinct, and more nearly allied to *Rhodocrinus*.

So far as we know, the group under consideration seems to be almost entirely confined to the Subcarboniferous rocks, both in this country and England. We know of but a single species (*Trematocrinus spinigerus*, Hall, found in the Hamilton group of New York) from any other horizon, and it is worthy of note that this species departs in some respects from the other known species of this group, and may belong to another genus.

SUBGENUS GONIASTEROIDOCRINUS, L. and C. (See p. 219.)

GILBERTSOCRINUS FISCELLUS, M. and W.

Pl. 15, Fig. 5.

Trematocrinus fiscellus, Meek and Worthen, Sept., 1860. Proceed. Acad. Nat. Sci., Philad., p. 383.

Gilbertsocrinus (*Goniasteroidocrinus*) *fiscellus*, M. and W., Aug., 1865. Ib., p. 167.

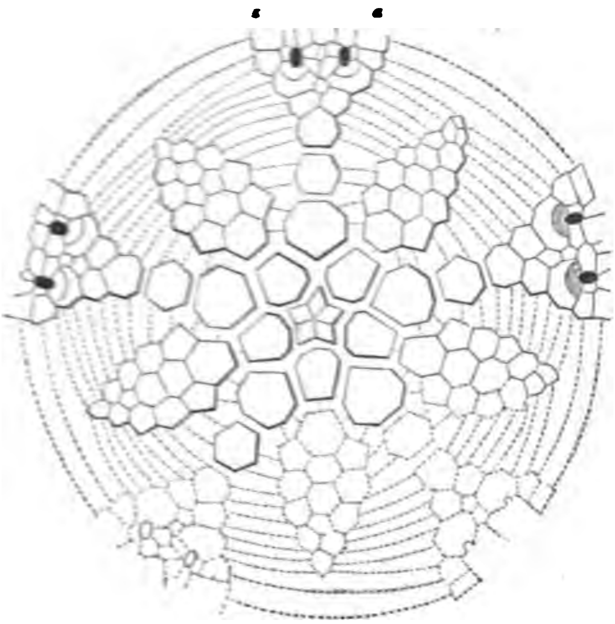
Body short subcylindrical, longer than wide, rounded and concave below, and nearly flat above; sides rising almost vertically to near the summit, where they curve outward. Plates subgranulose, and all convex, those of the subovate interradial spaces less prominent than the rays, and showing a very slight tendency to develope obscure radiating ridges near the edges; sutures distinct. Base small, somewhat concave, obscurely pentagonal, and included within the concavity of the under side; columnar facet comparatively large, or occupying nearly the whole area of the base, obscurely marked by radiating striæ, and provided with a small, pentagonal, star-shaped central opening. Subradial pieces nearly as wide as long, truncated, and narrower above than below, subquadrangular in general outline, but provided with a fifth very obtuse angle in the middle below, and having each inferior lateral angle slightly truncated. First radial pieces larger than the subradials, and wedged so far in between them as to come nearly in contact with the base, as wide as long, and heptagonal in outline, the sides connecting with the subradials being longer than the others. Second radials smaller than the first, about as long as wide, hexagonal in form. Third radials of the same size as the second, heptagonal, and supporting on their superior sloping sides the first secondary radials, each of which is succeeded by another, the last of which bear on their inner sides above, the delicate pendulous arms, and on the outer sloping sides above, one or two pieces forming the bases of the false arms. The first interradial and first anal pieces rest upon the broad, superior, truncated side of the subradials, which they nearly equal in size. They are all hexagonal, the inferior edges being generally longer than either of the others. Above these, there are in the second range three, in the third three or four, and in the fourth three pieces, the latter being surmounted by three or four others; all the series diminishing gradually from below to the summit.

The interaxillary pieces are all very small, two of them being wedged down, one upon the top of the other, in the narrow space between the first and second secondary radial pieces, while the others are arranged above, so as to form the upper and inner sides of the two small apertures; the outer and lower sides of which are formed partly by a sinus in the edge of the second secondary radial pieces, and partly by one side of the third.

The secondary radials diverge so that those belonging to each of the different rays (*a a* of diagram) meet over the centre of each interradial space, where they support the false arms. The first false arm pieces are not quite free, being flanked on either side by the interaxillary pieces forming the summit of the interaxillary openings. They are all pierced directly through the middle by small perforations.

The summit is very slightly convex, and composed of unequal plates, the larger of which are tumid, and the smaller less convex. Extending from each false arm towards the middle, there is a depression, occupied by smaller pieces, while the larger and more convex plates occupy the prominences between. Height, to top of first false arm-pieces, 0.48 inch; do. to the true arm-openings, 0.39 inch; do. to the top of the vault, 0.56 inch. Breadth of body below the arms, 0.51 inch.

Fig. 2[illegible].



Gilbertsocrinus fiscellus. (Magnified two diameters.)

In this diagram, showing the structure of the body out to the false-arm bases, the anal area and a part of each ray on that side, are restored. It is probable, however, that the anal area may have more plates than here represented, as we have reason to believe it was not isolated from the vault, like the interradial areas. The last piece of the divisions of each ray, marked *a*, connect laterally over each interradial space, and form the bases of the false arms. The dark spots are the true arm-openings.

The specimen from which our description is made out is defective on the anal side, but we have seen another, apparently of the same species, consisting of the vault and the false arm-bases, together with the sides down to the true arm-openings, inclusive. In this the anal area is clearly not insolated from the vault, and there are two false arms over the anal area, which are smaller than the others, and stand one on each side of the summit of the anal space, there being thus six, instead of five, of the false arms in this species. These smaller false arms are probably simple all the way out, while the larger ones probably bifurcate. The anal opening in this specimen is nearly midway between the middle and the margin, and opens obliquely outwards, with slightly protuberant margins.

This species is more nearly related to *Gilbertsocrinus tuberculosus*=(*Trematocrinus tuberculosus*, Hall, *Sup. Iowa Report*, page 75), than to any other with which we are acquainted. It differs, however, in being proportionally higher, and in having smaller and much less prominent subradials, which are but slightly convex, and so short as to be scarcely visible in a lateral view; while those of *G. tuberculosus* are described as being "produced into strong tuberculiform nodes," and extending up so as to form a part of the outer walls of the body. It likewise differs in having its first radial plates merely rather distinctly convex, and larger than the subradials, instead of smaller and "strongly tuberculiform." Again, it seems to differ in having the plates, especially those of the interradials, somewhat excavated at the corners, so as to present the appearance of a slight tendency to develope obtuse radiating costæ at the margins of the plates—a character not mentioned in Prof. Hall's description. A more important difference, however, if we are not mistaken in regard to the specimen we have mentioned as showing the summit, being identical with the type of our species, is, that it possesses six instead of five false arms, owing, as it were, to the division of the one on the anal side into two, each of which latter are only half the size of the others. Another difference is, the more lateral position of the opening of the summit, and the connection of the anal series with the vault above, in our species.

Should Cumberland's name, *Ollacrinus*, be adopted for this genus, the name of this species will of course be *Ollacrinus fiscellus*.

Locality and position: Lower beds of Burlington group of the Subcarboniferous series.

ECHINOIDEA.

PERISCHOECHINIDÆ.

(*Synon.*—Family TESSELES, Desor.)

RATHER widely different views are entertained amongst Zoologists and Palæontologists in regard to the importance of the characters distinguishing the Palæozoic group of *Echinodermata*, under consideration, from the Mesozoic and more modern Echinoids. Pictet, and some others, not only include these ancient forms in the order *Echinoidea*, but even view them as forming a section of the family *Cidaridæ*.* Desor also included them in the order, but regarded them as constituting a distinct family, for which he proposed the name *Tesseles*, and placed them, along with the *Cidaridæ*, as a suborder "*Endocycliques;*"† which arrangement was also followed by Dujardin and Hupe.‡ McCoy, however, had previously proposed to erect this group into a distinct order, under the name *Perischoechinidæ*,§ and Roemer regarded them as constituting a suborder of the *Echinoidea;*|| while Prof Agassiz, if we mistake not, thinks the group falls more properly within the *Crinoidea.*

Without presuming to undertake the decision of a question upon which such eminent authorities have differed, we must confess that a careful study of an extensive series of excellent specimens of *Melonites multipora*, with more or less perfect examples of *Oligoporus*, *Palæchinus*, *Archæocidaris* and *Lepidechinus*, compels us to concur with those who regard these types as Echinoids. Although evidently most nearly allied to the *Cidaridæ*, they still seem to present too strongly marked differences to be properly included in the same suborder; and hence we agree with Dr. Roemer in viewing them as constituting a distinct suborder, for which McCoy's name *Perischoechinidæ* may be retained. In a systematic arrangement their position would doubtless be below all the other Echinoids, and next to the *Cidaridæ*, thus forming a distinct suborder from the higher Echinoids.

The reasons for adopting the conclusions that these forms are true Echinoids and not Crinoids, are, that in the first place, they differ from the Crinoids and agree with a large group of the Echinoids (*Cidaridæ*) in having an anal and an oral opening, situated at opposite extremities of the vertical axis, with regular ambulacra extending the entire distance from one to the other of these openings, while they also possess an apical disc, composed of a series of ocular and ovarian pieces (the latter pierced by genital pores), surrounding the anal opening. Again, like the *Cidaridæ* and some other Echinoids, and unlike any known Crinoids, they were provided with powerful jaws; while they farther agree with the Echinoids, and differ from all the known Crinoids, in the possession of articulating spines.

We are aware the opinion has been expressed that *Melonites multipora* was attached by pedicel or jointed column, like the Crinoids—an error probably originating from the occasional occurrence of specimens crushed together in

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* Traite de Paleont., iv, p. 257, 1857.

† Synopsis Ech. Foss., p. xxvii, 1858.

‡ Nat. Hist. des Zooph., Suites du Buffon, p. 461, 1865.

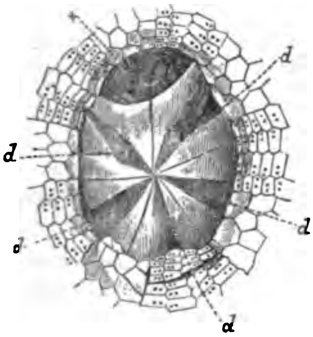
§ Brit. Palæozoic Foss., p. 124, 1851.

|| Wiegmann's Arch., i, p. 312, 1855.

the same mass with Crinoid columns, as we often see other fossils. No one, however, we believe, who has had an opportunity to examine a good series of specimens, entertains such an opinion at this time. Indeed, aside from all other reasons for rejecting this view, it seems to be against all analogy to suppose these creatures would have been provided with such powerful jaws, unless they were free to seek and devour larger food than the minute floating objects upon which the Crinoids probably subsisted.*

The existence of jaws in the genus *Archæocidaris* is shown in the figures of *A. Wortheni* of Hall, on *plate* 26, *of the Iowa Report*, though no allusion is there made to them in the text. We have also, now, the means of showing that the genus *Melonites* was provided with similar jaws. The annexed cut (No. 21) represents these jaws as seen in a specimen of *M. multipora*—the peristome being somewhat distorted and the jaws displaced by pressure, so as to leave an open space (*x*) on one side. The dark spaces (*d d d d d*) between the jaws are slightly restored near the centre of the figure, where the specimen is somewhat defective from accidental erosion. The five radiating lines between these dark bands are suture lines, extending up the middle of each jaw, as we see in those of *Archæocidaris* and some recent Echinoids.

Fig. 21.



Oral opening (somewhat distorted) and jaws of *Melonites multipora*—(natural size).

In the number of Wiegmann's Archives, already cited, Dr. Roemer gives excellent figures of the general appearance, of *Melonites multipora*, and of the arrangement of its ambulacral and interambulacral pieces. He also there gives a figure of the apical disc of the same, but the last mentioned figure differs in several respects from the specimens examined by us. In the first place this figure leaves a black ring around the disc, so as not to show the connection of the ambulacral and interambulacral pieces with the genital and ocular plates. It also represents pores in each of the ocular pieces, and only three in four of the genital pieces, and two in the fifth; while it represents the genital and ocular plates of nearly equal length. As may be seen by the annexed figures, the specimens examined by us have the ocular pieces much smaller and shorter than the others, and entirely without any traces of pores,* while one of the specimens before us shows distinctly four pores in three of the genital plates, and five in each of the other two. Another specimen (annexed fig. 22) shows five pores in three of the genital pieces, and four in each one of the others. In order to be the more sure that we were not mistaken in regard to the number and arrangement of the pores, we polished the surface of the whole disc in both of these specimens with fine emery, and owing to the white opaque character of the plates, and the fact that the pores are filled with darker, translucent material, the number of pores, and the relations of all the parts, could be very clearly seen. It is probable that one of these slightly larger plates with five pores, represents the madreporiform body, and thus faintly indicates the posterior side of the fossil.

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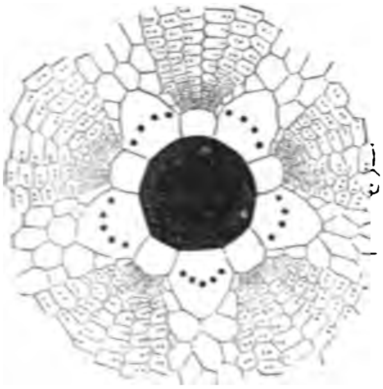
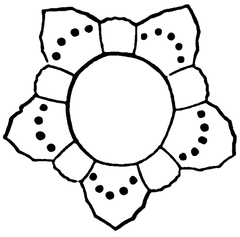
* The not unfrequent occurrence of Crinoids, imbedded with the shells of *Platyceras* and other Gasteropods, in contact with the vault, has led some Palæontologists to the conclusion that in these cases, the Crinoid was in the act of devouring the Mollusk at the moment when it perished. Some even seem to think that the Crinoids actually swallowed these shells. This, however, to say the least of it, would have been a physical impossibility, since the oral opening, when found with its margins entire, is rarely so much as the tenth of an inch in diameter, and is also often placed at the extremity of an elongated, slender tube or proboscis, made up of close-fitting solid plates. We also think it exceedingly improbable that the palæozoic Crinoids ever preyed upon even the softer parts of such large objects, though we are far from being willing to adopt the conclusion of M. M. Dujardin and Hupe, that they were entirely nourished by absorption over the surface.

Fig. 21.



Apical disc of *Melonites multipora*: Showing the anal opening surrounded by the genital and ocular pores, and the connection of the latter with the ambulacral and interambulacral pieces. All enlarged about two diameters.

Fig, 22.



If the disc figured by Dr. Roemer is accurately represented, it would seem to present a difference of even more than specific importance, from those examined by us, unless the difference might be sexual. The latter suggestion, however, is not probable, though from all analogy we may infer that the sexes were distinct in these fossils.

From the foregoing remarks and illustrations, it will be seen that the group *Perischœchinidæ*, which is entirely confined to the palæozoic rocks, differs from all the Mesozoic and more modern Echinoids, in having from three to seven or nine rows of interambulacral plates to each series, instead of only two (those of the inner rows being hexagonal, and the two outer pentagonal); and judging from what is known of *Melonites*, also in having a greater number of pores in each ovarian plate, with likewise sometimes a greater number, and different arrangement, of ambulacral plates and pores.

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* Since this was written, we have, through the politeness of Dr. Shumard of St. Louis, had an opportunity to examine another fine specimen, showing the disc of this fossil. In this there are four ovarian pores in three plates, and three in each of the other two; while in two of the occular pieces there is apparently a single pore near one side. Hence it would appear to be the case that the individuals of this fossil present unaccountable variations in the number of these pores.

Prof. McCoy has, apparently upon sufficient grounds, proposed to divide this group into two sections or families, distinguished by the following characters:

1. *PALÆCHINIDÆ*, McCoy.

   With spines small, all of one kind, and articulating upon imperforate tubercles. Includes *Melonites*, *Oligoporus* and *Palæchinus*.

2. *ARCHÆOCIDARIDÆ*, McCoy.

   With plates comparatively thin, and spines of two kinds—a smaller secondary series, and a larger primary series; all articulating upon perforated tubercles. Includes *Archæocidaris* and apparently *Perischodomus*.

It is possible *Lepidechinus*, Hall (which seems to be very near *Perischodomus*, McCoy), may be found to typify a third section or family, on account of its peculiar character of having all the plates distinctly imbricating.

GENUS PALÆCHINUS, McCoy, 1844.

(Carb. Foss. Ireland, p. 171.)

THE species belonging to this genus are usually large, oval or spheroidal, and composed of comparatively thick plates, which are provided with numerous small spines. In the interambulacral areas, there are five to six or eight ranges of plates, those connecting with the ambulacra being pentagonal, and all the others hexagonal, as in other groups of the suborder. The ambulacra are narrow, even, or but slightly furrowed, and each composed of two alternating ranges of small pieces, which are wider than long. Each of these pieces is perforated at the outer end by two small pores, arranged so as to form two double rows, or two single zigzag ranges, to each ambulacrum.

One species of this genus is said to occur in the Upper Silurian Rocks, and all the others known, have been found in the Carboniferous System.

PALÆCHINUS BURLINGTONENSIS, M. and W.

Pl. 16, Fig. 3 *a*, 3 *b*, 3 *c*.

Palæchinus burlingtonensis MEEK and WORTHEN, Sept., 1860. Proc. Acad. Nat. Sci., Philad., p. 396.

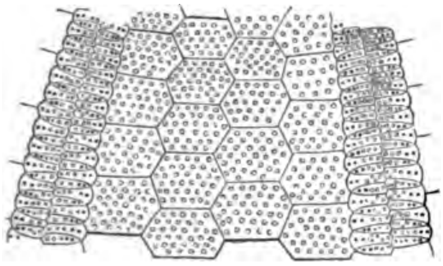
THE only specimen of this species we have yet seen, is too imperfect to show the exact form of the entire fossil, though it seems to have been nearly spherical in outline. It appears to have only four ranges of interambulacral plates in each area, though it is probable there are at least five, nearer the middle than they can be traced in our specimen. At the extremities of the interambulacral areas the number of plates is reduced to the two lateral ranges of pentagonal pieces, all of which have their truncated margins crenulated for the reception of the outer ends of the small ambulacral pieces.

The ambulacra are narrow, or about as wide as the first range of interambulacral plates on each side, and slightly convex along the middle. They are each composed of a double alternating series of very small pieces, which are two or three times as wide as long. About five to seven of these equal the height of each contiguous interambulacral plate, while the two pores in the outer ends of each piece are arranged so as to form two double, somewhat zigzag, rows in each ambulacrum.

The surface of all the plates is ornamented by numerous granules, or bases of attachment for the small spines, from thirty to forty of which occupied each of the interambulacral plates, and two or three each of the ambulacral pieces.

As near as can be determined from our imperfect specimen, it must have been, when entire, not less than 2.25 inches in height, and near two inches in breadth. About twelve of the ambulacral pieces occupy a space of 0.25 inch.

Fig 23.



Palæchinus burlingtonensis.

Diagram showing a part of two ambulacra, and the intervening interambulacral pieces, above the middle of the body; all magnified near two diameters.

This is the first species of this genus, we believe, identified in this country, though Prof. Hall has since described a species from the Burlington limestone, which he refers to a section of this group. From the description given by him, however, we are inclined to think his species differs too widely from the forms upon which McCoy's genus was founded, to be properly placed in it.

Locality and position: Burlington group, Subcarboniferous; Burlington, Iowa.

MOLLUSCA.

LAMELLIBRANCHIATA.

GENUS AVICULOPECTEN, McCoy, 1851.

(Ann. Mag. Nat. Hist., vol. vii, p. 171.)

AVICULOPECTEN BURLINGTONENSIS, M. and W.

Pl. 16, Fig. 1 *a* and 1 *b*.

Aviculopecten burlingtonensis, MEEK and WORTHEN, Oct., 1860. Preceed. Acad. Nat. Sci., Philad., p. 453.

SHELL of about medium size, very thin and fragile, subcircular, slightly wider than long; pallial margin regularly rounded lateral margins; more narrowly rounded near the middle, thence converging towards the beaks at an angle of about 100°; hinge straight, between two-thirds and three-fourths as long as the transverse diameter of the valves, and ranging at right angles to the longitudinal axis of the shell. Left valve much compressed; anterior ear of moderate size, flat, subtriangular, the extremity being a little rounded—separated from the margin below by a nearly rectangular notch;

posterior ear somewhat larger than the other, flat, and terminating in an angle of 45° at the extremity—separated from the margin below by a wide, deep, subangular sinus, beak compressed and located slightly in advance of the middle of the hinge. Surface (left valve) ornamented by eighty to ninety small, nearly equal, radiating costæ, which increase by implantation, and about equal the breadth of the depressions between; costæ crossed by numerous, very regular, undulating, and distinctly imbricating, concentric laminæ of growth, which are very closely arranged and sharply elevated on the ears, where the radiating ribs are not developed. (Right valve unknown.) Length from hinge to base, about 2.24 inches; breadth from anterior to posterior side, about 2.27 inches; length of hinge, 1.68 inches; number of costæ in 0.40 inch at the ventral margin, 10 to 12; number of concentric marks in same space, about 18.

In its peculiarly delicate surface markings, this shell closely resembles *A. cœlatus*, of McCoy', as figured in his *Palæozoic Fossils, pl.* 3 *E, fig.* 5 *and* 5 *a*. It differs, however, materially in form, its lateral margins being more abruptly rounded, and the sinuses under the ears deeper and more angular. It also differs in being entirely destitute of any traces of radiating costæ on the ears.

Loality and position: Burlington, Iowa; upper part of Burlington group of the Subcarboniferous series.

INVERTEBRATE FOSSILS OF THE KEOKUK GROUP.

PROTOZOA.

SPONGIÆ.

PETROSPONGIA.

Genus SPHENOPOTERIUM, M. and W., 1860. (See p. 145.)

Sphenopoterium obtusum, M. and W.

Pl. 17, Fig. 2*a*, 2*b*, 2*c*, 2*d* (by error *a* on the pl.), 2*e*.

Sphenopoterium obtusum, Meek and Worthen, Oct., 1860. Proceed. Acad. Nat. Sci., Philad., p. 448.

Short, abruptly cuneate below, wider than high; basal edge slightly sinuous in the middle; flattened sides, expanding rapidly upwards from the obtuse basal carina. Cells from four to about nine, comparatively large, and of moderate depth, conical, and where not more than four or five, rounded and separated by thick interstices, but becoming angular, with thinner intervening partitions, where more crowded. Surface striæ fine, irregular, and showing a tendency to converge towards the middle of the base, anastomosing in such a manner as to form a kind of shagreen-like style of ornament. Length or height of a large individual containing nine cells, 1 inch; breadth of same, 0.98 inch; thickness, 0.66 inch.

Locality and position: Nauvoo, Illinois; Keokuk division of the Subcarboniferous series.

SPHENOPOTERIUM COMPRESSUM, M. and W.

Pl. 17, Fig. 1*a*, 1*b*, 1*c*.

Sphenopoterium compressum, MEEK and WORTHEN, Oct., 1860. Proceed. Acad. Nat. Sci., Philad., p. 448.

COMPRESSED-CUNEATE, wider than high, carinate on each lateral margin, and sulcate between the cells on each compressed side; base apparently retaining remains of a scar of attachment. Cells three or more, arranged parallel to the greater transverse diameter of the body, rather deep and conical; walls thin. Surface presenting a fine shagreen-like appearance from the anastomosing of the striæ. Length or height, about 0.55 inch; greatest breadth, near 1 inch; thickness, 0.38 inch.

It is possible this may be a variety of the preceding species, though its more compressed form, thinner walls and lateral carinæ, give it a very different appearance. Its surface striæ are also finer and more broken up into granules.

Locality and position: same as last.

RADIATA.

ECHINODERMATA.

CRINOIDEA.

GENUS CYATHOCRINUS, Miller, 1821. (See p. 175.)

CYATHOCRINUS ANGULATUS, M. and W.

Pl. 17, Fig. 4.

Cyathocrinus angulatus, MEEK and WORTHEN, Sept., 1860. Proceed. Acad. Nat. Sci., Philad., p. 391.

BODY rather large, strong and robust, basin-shaped below the arms, wider than high, truncated below, and expanding rapidly upwards; composed of very thick, nearly smooth, or subgranulose, tumid and angular plates, which are united by distinct sutures. Base comparatively small, and apparently truncated on a plane with the tumid portion of the subradial plates. Subradial plates as wide as high, four of them pentagonal, and one on the anal side hexagonal, there being no visible angle at the middle of the base in any of them. First radials larger than the subradial pieces, about twice as wide as long, pentagonal or subheptagonal, in consequence of the superior lateral angles of some being truncate for the reception of small interradials; all broadly truncated and more or less concave above. Second radials extremely short, but differing somewhat in length, some of them eight or nine times as wide as long. Third radials larger than the second, unequal in size, all wider than high, and triangular in form. First anal plate smaller than the subradials, a little narrower below than above, apparently pentagonal in outline (the upper extremity is not distinctly seen in the specimen described), and extending somewhat above the summit of the first radials.

Arms large, rounded and robust, apparently simple after the division on the third radials, and composed each of a single series of pieces, which are wider than long, and somewhat wedge-shaped. Plates, below the second radials, remarkable for their thickness and tumid angular character, though the angles are not acute. On the subradials two of these ridges pass from the middle to the base, nearly parallel to each other (leaving a shallow furrow between), and one to each of the first radial pieces above. On each first radial there are two similar ridges or prominences, which diverge from near the upper side to the base, so as to connect with those on the subradial pieces, giving to each first radial a somewhat bilobate appearance.

Our specimen of this species is too much distorted to enable us to give accurate measurements, though the body below the arms seems to have been about 0.50 inch in height, and near 1.10 inches in breadth. It is more nearly related to *Cyathocrinus sculptilis*, Hall, than to any other species with which we are acquainted, but is much more robust, while the truncate upper sides of its first radials are not near so sloping outwards, nor so flattened. The ridges on its subradial and first radial pieces are less angular, and the surface of these plates is otherwise smoother than in *C. sculptilis*, which holds a lower geological position.

Locality and position: same as preceding.

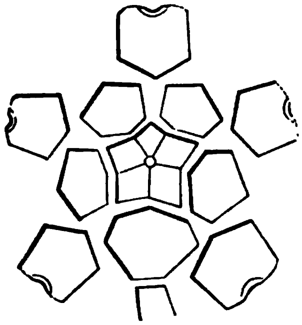
CYATHOCRINUS SAFFORDI, M. and W.

Pl. 17, Fig. 5 *a*, 5 *b*.

Cyathocrinus Saffordi, MEEK and WORTHEN, Sept., 1860. Proceed. Acad. Nat. Sci., Philad., p. 371.

BODY subglobose, wider than high, the broadest part being below the middle, unsymmetrical (at least in our specimen), the ventral side being much more gibbous than the other; composed of thin, smooth, or finely granulose plates, connected by linear, slightly carinated sutures. Base irregularly pentagonal, flat, or so slightly convex as to be scarcely visible in a side view, consisting (in the specimen before us) of unequal plates, those on the anal side being larger than the others, slightly protuberant at the columnar facet. Subradial plates rather large, unequal, wider than high, four of them hexagonal (the inferior angle being nearly obsolete), and one on the anal side —which is considerably larger than the others—irregularly heptagonal. First radial plates a little longer than the subradials, somewhat unequal, hexagonal, generally wider than high, and narrowing upwards from the inferior lateral angles; bordered above by a slender, slightly reflexed rim; sinus in the superior edge for the reception of the second radial pieces, small. Anal plate small, about as wide as high, quadrangular, and like the first radials, provided with a slightly reflexed rim above; not projecting above the margin of the radial plates on each side of it. Height to summit of first radials 0.50 inch; greatest breadth, 0.70 inch.

Fig. 24.



Cyathocrinus Saffordi.—(Nat. size.)

This cut shows the form and arrangement of the basal, subradial, first radial, and anal pieces.

This species is more nearly allied to *C. rotundatus*, of Hall, (*Iowa Report, vol. I, part ii, p.* 555, *pl.* 9, *fig.* 7 *a and* 7 *b*), than to any other with which we are acquainted. It differs, however, in being broader in proportion to its height, and is more nearly of the same height on the anterior and posterior sides. Its plates are also proportionally thinner, while the depressions in the upper margins of its first radial plates are more shallow, and not near so much beveled. Another marked difference is the peculiar character of its sutures which are indicated by a distinct, raised line. Its first anal plate likewise differs in being truncated very nearly on a level with the first radial on each side, instead of projecting above. They are both very irregular forms, in which the columnar facet is much nearer the anterior than posterior side.

The specific name of the form under consideration was given in honor of Prof. Safford, the State Geologist of Tennessee.

Locality and position: White's Creek Springs, Tennessee; Keokuk limestone.

GENUS POTERIOCRINUS, Miller. (See page 179.)

SUBGENUS SCAPHIOCRINUS, Hall, 1858.

(Iowa Report, vol. i, part 2, p. 550.)

Subgeneric formula.—

Basal plates, 5.
Subradial plates, 5.
Radial plates, $2+5=10$; or sometimes more than 2 in anterior ray.
Anal plates, 1 to 6, or more.
Interradial plates, 0.
Arms, $2+5=10$, two from each ray, simple or bifurcating.

THIS group agrees in nearly all its essential characters with Troost's genus *Zeacrinus*, so far as the number and arrangement of its parts are concerned, but differs from most of the species of that genus, in having its body obconical, or produced so as to show the basal pieces in a side view, instead of concave. It also differs in having the second radials and the lower arm joints proportionally longer, and contracted on the sides, while the sutures between the first and second radials, as well as between the second radials and the first arm pieces, are generally more gaping. In most of the species all the arm joints are proportionally longer, and more wedge-shaped than in the characteristic species of *Zeacrinus*. From the typical forms of *Poteriocrinus* it differs chiefly in having but two primary radial pieces in the posterior and lateral rays, and in the gaping character of the sutures between those pieces.

Prof. Hall ranges this group as a subgenus under *Poteriocrinus*. If Troost's genus *Zeacrinus* is to be retained as distinct from *Poteriocrinus*, it seems to us from the species we have had an opportunity to examine, that *Scaphiocrinus* might, with about as much propriety, be placed under the former, since the species show no fundamental differences of structure from those of that group. In order to fully comprehend the close relations between these groups, in the number and arrangement of their parts, it is but necessary to compare the diagram of *Zeacrinus ramosus*, Hall (*Iowa Report*, *vol. I*, *part ii*, *p.* 549), with his *Scaphiocrinus divaricatus* (*Sup. Iowa Repot*, *pl.* 3, *fig.* 6.)

As already suggested in another place, it is not improbable that the type of de Koninck and Lehon's genus *Graphiocrinus*, will be found to possess five small basal pieces hidden by the column, within the range regarded as basals by those authors. If so, we can scarcely doubt that *Zeacrinus* and *Scaphiocrinus* should either be grouped together as a subgenus under *Graphiocrinus* (which has priority), or stand under it as two distinct subgenera; unless all three should be included as sections of *Poteriocrinus*.

SCAPHIOCRINUS DECADACTYLUS, M. and W.

Pl. 17, Fig. 6.

Poteriocrinus (*Scaphiocrinus*) *decadactylus*, MEEK and WORTHEN, Sept., 1860. Proceed. Acad. Nat. Sci., Philad., p. 394.

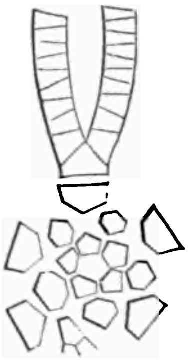
BODY rather small; broad obconical below the second radial pieces, expanding somewhat rapidly from the base; plates rather thick, and nearly or quite smooth; sutures between the first and second radial plates, and between the second radials and the first arm-pieces, gaping. Base small, convex, or about half as high as wide, pentagonal in outline, as seen from below.

Subradial plates somewhat unequal, a little wider than long, four of them apparently hexagonal, and one on the anal side heptagonal. First radial plates about twice as large as the smaller of the subradials, hexagonal in form, and all wider than long, the upper horizontally truncated side being longer than either of the others. Second radials about the size of the first, pentagonal, a little wider than high, truncated below, and provided with a salient angle in the middle above; all rounded on the outer side, and a little concave on each short lateral margin.

First anal plate rather large, or equaling some of the subradials in size; irregularly pentagonal or hexagonal in form, and resting between the superior sloping sides of two of the subradials; supporting on its right sloping side an inferior edge of one of the first radial pieces, while it supports two smaller pieces in the second range, the exact form of which cannot be made out in our specimen.

Arms long, robust, subcylindrical, rather unequal in size, and apparently all simple after the division on the second radials, entirely composed of a single series of pieces, a few of the first of which are longer than wide, and alternately longer and shorter on opposite sides; farther up they become more regular, and shorter than wide. Column rather small, or less than the diameter of the largest arms, round, and composed of thin, slightly unequal segments, near the body. Its central cavity small, and presenting a regular pentapetalous section. Height of body to the summit of the second radials, about 0.50 inch; breadth near the same. Length of arms apparently not less than 2.50 inches; breadth of do., from 11 to 0.16 inch.

Fig. 25.



Poteriocrinus decadactylus. (Nat. size.)

Diagram showing the form and arrangement of the basal, subradial, first primary radial and anal pieces, with the second primary radial, and portions of the arms of the anterior ray.

This species, like *Scaphiocrinus simplex* of Hall, (*Iowa Report*, *vol. I*, *p.* 551) differs in being more robust, and in having a more projecting base, while its arms are stouter and composed of comparatively shorter and less distinctly wedge-formed pieces, which show no lateral projections for the support of the tentacles. Again it differs in having its first anal piece alternating with two of the subradials, instead of resting upon a truncated upper side of one of them.

Locality and position: Appanoose, Hancock county, Ill.; Keokuk limestone of Lower Carboniferous series.

GENUS ZEACRINUS, Troost. (See page 185.)

ZEACRINUS PLANOBRACHIATUS, M. and W.

Pl. 18, fig. 5.

Zeacrinus planobrachiatus, MEEK and WORTHEN, Sept., 1860. Proceed. Acad. Nat. Sci., Philad., p. 391.

BODY small, depressed basin-shaped below the summit of the first radials, concave beneath; composed of apparently smooth plates, connected by moderately distinct sutures. Base small, concave, and apparently nearly hidden by the column. Subradial pieces as wide as long, or a little wider, four of them hexagonal, and one on the anal side heptagonal, (counting three angles at the base of each). First radial pieces wider than long, expanding upwards from the base, apparently all pentagonal, the upper side being horizontally truncated, and longer than either of the others. Second radial pieces nearly as large as the first, presenting (in the posterior and lateral rays) a triangular outline, the lateral angles being probably sometimes truncated. First anal plate narrow below, and wedged down obliquely between one of the subradials and an inferior sloping side of one of the first radials; supporting one or two smaller pieces above, the exact forms of which cannot be made out in our specimen.

Arms rather flattened on the outside, and after dividing on the second radial pieces (in those seen), bifurcating again on the sixth piece; beyond this entirely simple, and each composed of a single series of pieces, which are slightly wider than long, and a little wedge-shaped, or alternately longer and shorter on opposite sides. On the long side they project a little above, for the reception of the tentacles, which are large, and composed of joints nearly twice as long as wide. Height to the summit of the second radials, about 0.17 inch; breadth at the top of the first radials, 0.27 inch; length of arms from their division on the second radial pieces, about 0.84 inch.

This species seems to be related to *Z. bifurcatus*, of McChesney (*Descr. New Palæozoic Fossils, p.* 9, *pl.* 5, *fig.* 3), but differs in being less robust, and in having proportionally broader subradial pieces, while the upper angle of its second radials is much more salient, and the pieces between the first and second bifurcations of its arms, are more wedge-shaped than is represented in the figure and diagram of *Z. bifurcatus.* The arms, or at least some of them. in Prof. McChesney's species, also bifurcate a third time, while in our species, they are entirely simple after the second division.

If, as has been suggested by Dr. Shumard and Mr. Lyon, the type of de Koninck and Lehon's genus *Graphiocrinus*, should be found to possess the same structure as Troost's *Zeacrinus*, de Koninck and Lehon's name, having priority, will have to take precedence, and the name of this species will have to be written *Graphiocrinus planobrachiatus.*

Locality and position: Near south line of Monroe county, Illinois; Keokuk group, of Subcarboniferous series.

GENUS ONYCHOCRINUS, Lyon and Casseday.

Synon.—Onychocrinus, LYON and CASSEDAY, 1859. Am. Journal Sci (2), xxix, p. 77. *Forbesiocrinus* (sp.), HALL, 1858· Iowa Report. Meek and Worthen (sp.), 1860; Proceed. Acad. Nat. Sci., Philad.; (not de Koninck and Lehon.)

ALTHOUGH for some time past inclined to regard the type for which the name *Onychocrinus* was proposed, probably in no respect distinguishable from *Forbesiocrinus*, a careful study and comparison of a number of specimens of these groups has led us to believe them most probably generically distinct. At any rate, they certainly differ upon more constant and more clearly defined characters than those separating *Forbesiocrinus* from *Taxocrinus*, which we have elsewhere shown,* blend into each other by such imperceptible gradations, that we we do not believe they can be separated more than subgenerically.

In the nature of the column, the number and arrangement of the basal, subradial and primary radial pieces, *Onychocrinus* agrees exactly with *Forbesiocrinus*, while in other respects the species of the former, particularly the typical species, differ from those of the latter in some points of structure that impart a peculiar physiognomy to the whole fossil, quite obvious even to the most careless observer, in examining entire specimens. In the first place, they differ from *Forbesiocrinus* in having the body more depressed, and the rays, from their origin, more diverging, or in some cases extending out horizontally on the same plane with the base; while in these extreme cases the long rays, which are free in to the second radials inclusive, bear the small arms in clusters at their extremities, remote from the body. In short, if we could open and spread out the rays of a *Forbesiocrinus* upon a plane as far in as to the second radial pieces, and then divide each of the interradial series of plates, and fold them up so as to cover the vault, and apparently to some extent the free rays, somewhat in the manner suggested by Prof. Agassiz for the ideal conversion of an Echinoid into a starfish, we would have a form very like the extreme *Onychocrinus*. Still there would be this difference, however, that in *Onychocrinus* the anal series of plates is almost entirely wanting, and the anal area open and so deeply excavated as often to completely destroy the symmetry of the body. That is, instead of having the anal area occupied by as many pieces as, or a greater number than, occupy the interradial areas, as in *Forbesiocrinus*, we find the whole anal series in *Onychocrinus*, whatever may be the number of interradials, reduced to a few very small pieces, ranged in a direct line, one upon another, and resting with the first or lowest one in a small sinus in the middle of the upper side of the large odd subradial, much as the arms of *Platycrinus* rest upon the first radials, and really looking very much like a diminutive arm rising from the middle of the anal area. This arm-like range of small pieces seems never to consist of more than from four to six or seven pieces, which are so small and narrow as to leave a wide, free, open space between them and the posterior rays on each side, as seen in our figure of *Onychocrinus monroensis*, plate 17, figure 7. How they connect with the vault we have never been able to make out, as they are always entirely disconnected from all other parts, excepting the subradial upon which they rest. We suspect, however, that they merely formed the outside of a small lateral proboscis, the inner side of which was composed of a soft, dermal integument, connecting with the vault.

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* Proceedings Academy Natural Science, Philadelphia, August, 1865, p. 138.

This peculiarity of the anal side has been entirely overlooked, or misunderstood in the species of this type referred to *Forbesiocrinus*, the impression being that the anal plates had been, by some accident, removed from their place. It is true, we had observed that the anal area in our *Forbesiocrinus monroensis* and *F. Norwoodi*, which belong to this group (though not extreme examples of it), is only occupied by a slender little finger-like appendage, resting upon the upper side of the odd subradial; but as stated in our description of the former species, we supposed the anal plates had been broken out, and that this little round, finger-like appendage, occupying their place, was one of the smaller divisions of the arms that had been accidentally placed in that position, in the only specimen of each of these species then known. Lyon and Casseday had, however, correctly described these as the anal pieces of *Onychocrinus.*

We have seen this character well defined in the following species, viz: *Forbesiocrinus asteriæformis*, *F. Whitfieldi* and *F. Meeki*, of Hall; and in our *F. monroensis*, *F. Norwoodi* and *O. diversus*, as well as in Lyon and Casseday's typical species. In the type of the species *F. Meeki*, now before us, the anal area, as may be seen by the figure in the Iowa Report, is entirely open, and even without the little finger-like appendage, which was broken out. In five other individuals, however, of this species we have seen, this character is unmistakably visible, and we have never seen a specimen of either this or any of the other species mentioned above, with the anal side filled with plates as in *Forbesiocrinus.*

From all the facts now known, we therefore incline to the opinion that these forms should be separated from *Forbesiocrinus*, under the name *Onychocrinus.* It is worthy of note, however, that this group seems to be even farther divisible into two rather distinct sections, upon characters the exact value of which we cannot satisfactorily determine without knowing more about the vault and upper side of these species. For instance, *O. asteriæformis*=(*Forbesiocrinus asteriæformis*, Hall), and our *O. diversus*, which are the extreme forms already referred to, differ from the other species mentioned, in having the rays more spreading, and free in as far as to the second or first primary radials, instead of being connected by many interradials, as in the other species, while their arms, which are proportionally small, are clustered together in little bunches at the extremities of the rays, far out from the body.

These last mentioned species, with their long spreading and bifurcating rays, bearing their numerous clusters of little, curled-up arms at their extremities, must have presented much the appearance of dried examples of the existing genus *Astrophyton*, though we cannot agree with Messrs. Lyon and Casseday, in the opinion that they form a connecting link between the *Crinoidea* and *Asteroidea*, or are more nearly allied to the star fishes than other palæozoic crinoids, their resemblance being merely simulative, and not due to any close analogy of structure.

The species of this group yet known to us, are confined to the Subcarboniferous rocks, and seem to be peculiar to America.

ONYCHOCRINUS MONROENSIS, M. and W.

Pl. 17, Fig. 7.

Forbesiocrinus monroensis, Meek and Worthen, June, 1861. Proceed. Acad. Nat. Sci., Philad., p. 130.

Body below the free arms apparently depressed basin-shaped, composed of nearly smooth rather thick plates, connected by linear sutures. Base small, and nearly hidden by the column. Subradial plates of moderate size, four of them pentagonal, and one on the anal side hexagonal, with unequal sides—its upper side being short, and distinctly sinuous in the middle, for the reception of the small first anal piece. First radials about twice as wide as high, hexagonal in form, and nearly twice as large as the subradials. Second, third and fourth radials in two of the rays (and one or two more in another), all nearly of the same length, hexagonal in form (excepting those on the two posterior rays, which have their ends next the anal space truncated so as to become pentagonal), and all nearly twice as wide as long. Last primary radial pieces smaller than the others, pentagonal, and supporting on their superior sloping sides the abruptly diverging first divisions, each of which latter gives out several branches above.

Of the interradials, the first is about the size of the subradials, hexagonal in form, and supports two smaller ones in the next range. Above the latter the rays diverge considerably, and it is evident there was at least a single row of small pieces fitting into the notches between the ends of the primary radials, but whether these curved up and connected with the vault, or whether they connected with others filling the whole interradial space between, our specimen is too imperfect to enable us to determine, though we think the former was the case.

Anal pieces, seven or eight known, very small, and showing the peculiarity characterizing the group very clearly, the whole range forming a little finger-like appendage about the size of one of the smaller divisions of the arms.

Column rounded and comparatively thick at its junction with the base, from which it tapers gradually towards the lower extremity; near the base composed of extremely thin equal segments, connecting by crenulated sutures, the crenulations being formed apparently by radiating striæ on the surfaces of the segments; farther down it gradually passes into a series of alternately thicker and thinner pieces.

Locality and position: Keokuk division of Subcarboniferous series; on the river bluffs, near south line of Monroe county, Illinois.

ONYCHOCRINUS NORWOODI, M. and W.

Pl. 17, fig. 3.

Forbesiocrinus? Norwoodi, MEEK and WORTHEN, Sept., 1860. Proceed. Acad. Nat. Sci., Philad., p. 389.

Taxocrinus Norwoodi, MEEK and WORTHEN, Aug., 1865. Proceed. Acad. Nat. Sci., Philad., p. 142.

Comp. *Onychocrinus exculptus*, LYON and CASSEDAY, 1859. Am. Jour. Sci. xxix, p. 78.

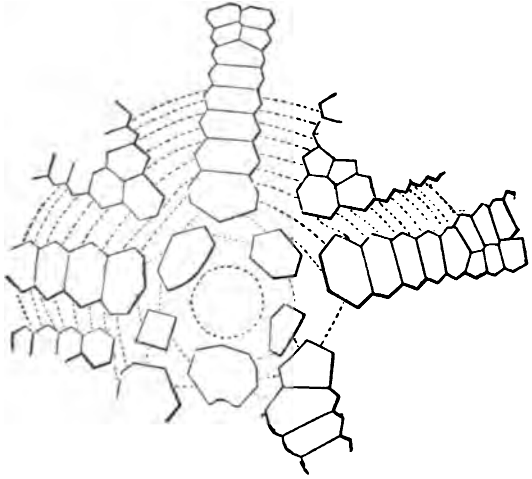
BODY below the last primary radial pieces, apparently short obconical, or expanding rather abruptly and regularly upwards from the base; composed of nearly smooth, thick plates, connected by linear sutures. Base small, consisting of very low, unequal pieces, which do not project out beyond the circumference of the upper extremity of the column. Subradial plates irregular in form and size, one of them apparently quadrangular, two pentagonal, one hexagonal, and one heptagonal, or octagonal. First radial pieces nearly twice as wide as long, two of them heptagonal, two hexagonal, and one apparently pentagonal; all more or less arcuate laterally; second, third and fourth radials (also the fifth in the anterior ray) not differing greatly in size, wider than long, and hexagonal in form. Fifth radials (sixth in the anterior ray) of the nearly same size as the others, heptagonal in form, and supporting on their sloping sides the secondary radials.

First interradials nearly half as large as the first radial plates, heptagonal and hexagonal in form, and each supporting two or three smaller pieces in the second range; above these, three or four pieces are seen in the next range, which is as far up as they can be counted in the specimen before us, though it is probable the number increased at the same rate for several ranges above. Anal pieces unknown, excepting the base of the first one, which is very small, and as usual in this group, rests in a sinus in the upper side of the large odd subradial piece; secondary radials above the first divisions of the rays on the fifth and sixth primary radial pieces, continued nearly on a line with the primary radials below, without diverging so as to leave any room for interaxillary pieces. In one of the posterior rays seen, a second bifurcation takes place on the fourth piece, beyond which the pieces in this ray are not preserved in our specimen.

Column round, comparatively thick at its connection with the base, from which it tapers towards the lower extremity; composed of extremely thin segments, fitting together by interlocking crenulations formed by the radiating striæ; its central cavity subcircular, or obscurely pentagonal, and about one-third as broad as the transverse diameter of the column.

The specific name was given in honor of Prof. J. G. Norwood, of the University of Missouri.

Fig. 26.



Onychocrinus Norwoodi. (Nat. size.)

This diagram shows the subradial, radial and some of the interradial pieces, as they appear to be arranged in a distorted specimen; with the radial series out a little beyond the first bifurcation.

This species will be distinguished from the last, not only by its larger size, and more robust habit, but particularly by having the two divisions of each ray, after they divide on the last primary radial, continued on for some distance, closely united, instead of abruptly diverging. Its subradial plates also appear to be widely different, though they seem to be somewhat abnormal in their form, in the specimen from which our diagram is made out.

Since seeing a specimen of *Onychocrinus exculptus*, of Lyon and Casseday, sent on to the Chicago Academy of Sciences, by Mr. Lyon, we suspect that the form under consideration may prove to be a variety of the same. Yet as it presents a greater irregularity in the size and form of the subradial pieces, and some differences in the form of the first radials, we have concluded to retain our name until we can have an opportunity to compare better specimens.

Locality and position: River bluff near the south line of Monroe county, Illinois; Keokuk division of the Lower Carboniferous series.

ECHINOIDEA

PERISCHOECHINIDÆ. (See page 225.)

Genus OLIGOPORUS, M. and W.

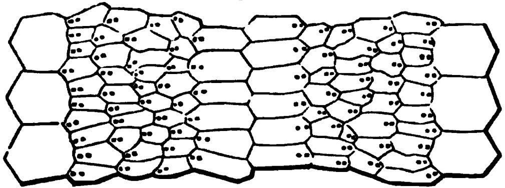
(*ολιγος*, few; *πορος*, a passage.)

Synon.—*Melonites* (sp.), Meek and Worthen, Sept., 1860. Proceed. Acad. Nat. Sci., Philad., p. 397; (not Owen and Norwood, 1846).

Oligoporus, Meek and Worthen, Sept., 1860. Proc. Acad. Nat. Sci., Philad., p. 474.

The specimen upon which this genus was founded, consists of two of the ambulacral series, and one entire intervening series of interambulacral plates, all in very nearly their natural position, excepting that the specimen is somewhat flattened by pressure. We at first referred it to the genus *Melonites*, but subsequently proposed to separate it, at least subgenerically, from the type of that genus, and later comparisons now lead us to regard it as generally distinct. So far as its characters can be made out, it seems to agree almost exactly with *Melonites* in size, form, the number and thickness, as well as the arrangement of its interambulacral plates, and in the breadth and deeply double furrowed character of its ambulacra. It differs, however, in the important peculiarity of having only four rows of ambulacral plates, and four double rows of pores, to each ambulacrum, instead of about ten of each. This difference will be more clearly understood by comparing the annexed cuts—No. 27 representing the number of rows and arrangement of the plates and pores in the ambulacra of *Melonites multipora*, and the cut No. 28 the same in *Oligoporus Danæ*, both from near the middle of the ambulacral series. Believing that this peculiarity in the form under consideration must have been accompanied by other equally important differences in the apical disc, and the structure of the softer parts of the animal, we can but regard it, with our present means of comparison, as the type of a distinct genus.

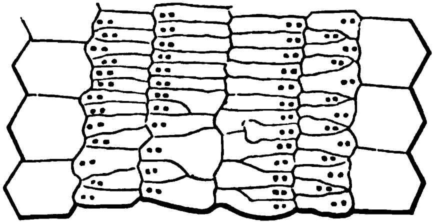
Fig. 27.



Melonites multipora. (Two diameters)

Diagram showing the number and arrangement of the rows of ambulacral pieces and pores, and the connection of the former with the interambulacral pieces on each side, near the middle of the ambulacral area.

Fig. 28.



Oligoporus Danæ. (Two diameters.)

Diagram showing the ambulacral pieces and pores, and the connection of the former with the first range of interambulacral pieces on each side, near the middle of the ambulacral area.

It will thus be seen that the type of *Oligoporus* seems to be almost exactly intermediate, in some of its characters, between

Melonites and *Palæchinus;* the number of its ambulacral plates and pores being only half as great as in the former, and double that of the latter. It evidently approximates *Melonites* more nearly, however, in having its ambulacra deeply furrowed, so as to impart the same melon-like form to the whole outline, that suggested the name *Melonites.* It also agrees more nearly with the latter genus, in the greater comparative breadth of its ambulacra, which are about half as wide in the middle as the interambulacral areas, while those of *Palæchinus* are only from one-fifth to one-seventh as wide as the interambulacral spaces.

It is barely possible that future discoveries may bring to light other intermediate forms, connecting *Melonites* and *Palæchinus*, through *Oligoporus*, by such gradations as to render it necessary to include the whole as sections of one genus.

When used as a generic name, *Oligoporus* is less appropriate for this type than when it is placed as a subgeneric name under *Melonites*, since it has more pores than any other known type of the suborder, excepting *Melonites.* Another objection to it is, that Desor had used the name *Oligopores*, in 1858, for a section of the *Cidaridæ.* As *Oligopores*, however, from its termination, is sufficiently distinct, and many quite as unappropriate names are retained in other departments of Natural History, we scarcely think it desirable to make a change. If others should think differently, however, it may be called *Melonopsis.*

OLIGOPORUS DANÆ, M. and W.

Pl. 17, Fig. 8.

Melonites Danæ, MEEK and WORTHEN, September, 1860. Proceedings Acad. Nat. Sci., Philad., p. 397.

Oligoporus, MEEK and WORTHEN, 1860. Ib., p. 474.

LARGE, subglobose, or depressed ovoid. Interambulacral areas lance-ovate in outline, moderately convex, occupied below the middle by nine vertical ranges of plates, near the middle by eight, a little higher by seven, and thus decreasing in number to four ranges at the highest point to which they can be traced in our specimen; the two outer rows of pentagonal pieces continuous, while four of the intermediate rows of hexagonal plates* terminate before reaching either extremity.

Ambulacral areas half as wide as the interambulacral spaces, and nearly as convex in the middle; while their broad furrow on each side of this mesial ridge is as deep as those of *Melonites multipora.* Ambulacral pieces somewhat irregular, in consequence of the intercalation of a few supplementary pieces, all wider than high, the breadth being from one and a half to seven times the height; those of the inner two rows a little wider than the outer two, and more irregular in form; usually from three to five of those of the outer two ranges occupying the vertical space of each contiguous interambulacral plate; intercalated pieces apparently always between those of the middle two ranges, but rarely extending into the mesial zigzag sutures. Ambulacral pores circular, two to each piece, and so arranged as to form four vertical ranges, the outer two ranges being more or less zigzag.

Entire surface occupied by regularly disposed granules, evidently the bases of small spines. Of these granules, about twenty-five may be counted on each of the larger interambulacral plates, and as many, in proportion to size, on each of the smaller ones, including the ambulacral pieces.

Our specimen is too imperfect to give exact measurements, but it indicates a height of about 4 inches, and a breadth of probably from 3½ to 4 inches below the middle. The greatest breadth of the interambulacral space is about 1½ inches, while the interambulacral plates agree in size and form with those of *Melonites multipora.*

Specifically this form will be at once distinguished from *Melonites multipora*, even in fragments, where the arrangement of the ambulacral plates can be seen, by their being but four ranges of these pieces, instead of twice that number. (See cut on p. 248.) It also seems to have differed in form somewhat, being apparently proportionally broader below the middle than above.

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* The terminal plate of these intermediate rows, usually differs from the others in being pentagonal, but not from the truncation of one side, like those of the marginal rows, on each side of the ambulacra.

Should future discoveries prove this type to be only one of a series connecting *Palæchinus* and *Melonites* as sections of one genus, its name would become *Palæchinus Danæ*, since *Palæchinus* has priority over either of the other names.

Locality and position: Jersey county, Illinois. Keokuk division of the Subcarboniferous series. Also at Warsaw, Illinois, at same horizon. We have likewise seen a specimen of apparently the same species, in Dr. Shumard's collection, from Fenton, St. Louis county, Missouri.

MOLLUSCA.

BRACHIOPODA.

GENUS CAMAROPHORIA, King, 1844.

(Ann. and Mag. Nat. Hist., vol. xiv.)

CAMAROPHORIA SUBTRIGONA, M. and W.

Pl. 18, Fig. 8*a*, 8*b*, 8*c*.

Rhynchonella subtrigona, MEEK and WORTHEN, Oct., 1860. Preceed. Acad. Nat. Sci., Philad., p. 451.

Rhynchonella Parvini, MCCHESNEY, Feb., 1861. New sp. Fossils from Palæozoic rocks of the Western States, p. 83; also, 1865, Illustrations of ditto, plate 6, figure 2.

Compare *Atrypa isoryncha*, MCCOY, 1844. Carboniferous Fossils, Ireland, p. 154;= *Camaropharia isoryncha*, MCCOY, 1852. British Pal. Foss., p. 444; Davidson's British Carboniferous Brachiopoda, p. 117, pl. xxv, figs. 1 and 2, 2*a* and 2*b*.

SHELL rather above medium size, trigonal-subglobose, wider than long, usually gibbous, truncated in front and on each postero-lateral slope; anterior margins of the valves sharply and deeply serrated; posterior lateral slopes each forming a flattened or concave oval space, without well defined plications, and limited by a more or less distinct angle on each valve. Ventral valve nearly flat, or arching a little from the umbo along the middle towards the front, on each side of which the antero-lateral margins are at first elevated, then very abruptly deflected towards the other valve; front curving down nearly at right angles to the plane of the valve, and extended so as to fill a broad, deep, rather rounded sinus in front of the other valve; postero-lateral margins also abruptly deflected to meet those of the opposite valve; beak small, rather pointed, incurved upon that of the ventral valve; mesial sinus very broad, shallow, and not distinctly defined. Dorsal valve much more gibbous than the other, the most convex part being in the antero-central region, thence sloping with a moderately convex outline to the beak; lateral and antero-lateral margins abruptly curved to meet those of the opposite valve; mesial elevation not well defined, rather flattened, and scarcely traceable to the middle. Surface of each valve ornamented by from about fourteen to eighteen rather rounded, or sometimes obtusely angular plications, which are defined to the beaks; four to six of these plications usually occupy the mesial sinus, and about the same number the mesial elevation. Fine, obscure, concentric striæ are also seen on well preserved specimens. Length of a medium sized, rather gibbous specimen, 0.90 inch; breadth, 0.98 inch; convexity, 0.91 inch.

At the time we published a description of this species, under the name *Rhynchonella subtrigona*, we had not access to Prof. McCoy's work on the Carboniferous Fossils of Ireland, nor had we received Mr. Davidson's valuable Monograph of the British Carboniferous Brachiopoda. Since seeing these works, we are strongly inclined to think our shell identical with *Camarophoria isorycha* of McCoy. Gibbous specimens of it certainly resemble *very* closely the figures of th species given by these authors. A large majority of the specimens, however, are less gibbous, while they all have the front more flattened at right angles to the plane of the valves, and the sinus and anterior projection of the ventral valve, broader. As it is not possible to determine, from the few figures yet published of the *C. isoryncha*, the extent of its variations in these characters, we do not feel quite warranted in referring our shell to that species.

All of the five other specimens we have had for comparison, are less gibbous and proportionally broader than the one we have figured, though one of them is considerably larger and none of them are smaller. On grinding across the beaks of one of these specimens, we find that it shows very satisfactorily the internal characters of the genus *Camarophoria*.

The specimen figured by Prof. McChesney, under the name *Rhynchonella Parvini*, seems not to have been in a condition to show very satisfactorily the characters of the species, being merely disunited valves, though his description agrees exactly with the specimens before us, which fact, taken in connection with the locality and position, leaves little room for doubt in regard to its identity with our shell. We may also add, that Prof. McChesney, on seeing our specimens, identified them with his *R. Parvini*.

Locality and position: Keokuk, Iowa; Nauvoo and Warsaw, Illinois, etc.; Keokuk division of the Subcarboniferous series.

GENUS CHONETES, Fischer, 1837.

(Oryctogr. Mosc., p. 134.)

CHONETES PLANUMBONA, M. and W.

Pl. 18, figs. 1*a*, 1*b*, 1*c*, 1*d*.

Chonetes planumbona, MEEK and WORTHEN, Oct., 1860. Proceedings Acad. Nat. Sci., Philad., p. 450.

SHELL of medium size, nearly semicircular; length from two-thirds to three-fourths the breadth; hinge line usually a little longer than the greatest breadth of the valves at any point farther forward; front rounded, or forming, with the sides, a nearly semicircular curve; lateral margins intersecting the hinge at generally less than a right angle. Ventral valve usually moderately gibbous, flattened at the umbo, most convex near the middle, and sloping down to the sides and front—destitute of any traces of a mesial sinus; ears a little compressed; cardinal margin sloping very slightly from the beak to the extremities, armed with some eight or ten oblique spines (only known from small remaining bases); area of moderate breadth; foramen rather broad-triangular, the upper angle being a little rounded; beak not incurved. Dorsal valve concave, or following nearly the curve of the other valve; cardinal process moderately prominent, nearly or quite closing the foramen of the opposite valve; interior without a prominent mesial ridge, more or less granular, the granules being often arranged in radiating lines; visceral scar rather large; impressions of adductor muscles small and not very deep. Surface of both valves, to the unassisted eye, apparently smooth, but showing, under a lens, nearly obsolete traces of radiating striæ, crossed by minute concentric lines or wrinkles. Length, 0.42 inch; breadth, 0.49 inch; convexity, 0.16 inch.

This species seems to be more nearly allied to *C. polita* of McCoy (*Brit. Pal. Foss.*, *p.* 456, *pl.* 3*D*, *fig.* 30), than any other Carboniferous species of the genus with which we are acquainted. It differs, however, in its larger size and more flattened umbo, as well as in showing no traces of the two prominent ridges in the interior of the dorsal valve, mentioned in Mr. Davidson's description of that species (*Brit. Carb. Brach.*). It also shows, on well preserved specimens, faint traces of moderately coarse radiating striæ, and none of the spine bases over the surface of the ventral valve, figured by Mr. Davidson.

Locality and position: Monroe county, Illinois; Keokuk division of the Lower Carboniferous series.

GENUS ATHYRIS, McCoy, 1844.[*]

(Carb. Foss. Ireland, p. 146.)

ATHYRIS PLANOSULCATA, Phillips? (sp.)

Pl. 22, fig. 8*a*, 8*b*, 8*c*, 8*d*.

Spirifer planosulcatus, PHILLIPS, 1836. Geol. Yorksh., vol. ii, p. 220, pl. x, fig. 15.
Atrypa planosulcata, SOWERBY, 1840. Min. Conch., vol. vii, p. 15, pl. DCXVII, fig. 2.
Atrypa oblonga, Ibid, fig. 3.
Atrypa planosulcata, DE KONINCK, 1843. An. Foss., p. 301, pl. xxi, fig. 1 and 2.
Actinoconchus paradoxus, McCOY, 1844. Synop. Carb. Foss., p. 150, pl. xxi, fig. 6.
Atrypa obtusa, McCOY, Ibid., pl. xxii, fig. 20.
Athyris paradoxa, McCOY, 1855. Brit. Pal. Foss., p. 436.
Athyris parvirostris, MEEK and WORTHEN, Oct. 1860. Pro. Acad. Nat. Sci. Phil., p. 451.

SHELL of medium size, quadrato-subcircular, moderately gibbous, length and breadth nearly equal, sometimes a little wider than long, (other examples a little longer than wide); greatest convexity at the middle; valves equally gibbous; lateral margins usually prominent and narrowly rounded in outline at the middle, thence converging with a slightly convex outline to the faintly subtruncate front; postero-lateral margins a little inflected, so as to form slight concavities, converging to the beaks at an angle of about 97°. Both valves destitute of a mesial fold or sinus, but each sometimes slightly flattened in the middle near the front, where they meet without the slightest sinuosity in the margin of either. Beak of ventral valve small, pointed, closely incurved upon that of the other valve, which is but little less prominent, foramen round and very small. Surface with small, obscure, concentric marks of growth. Spiral appendages each making about twelve turns. Surface (probably exfoliated) showing only small, obscure, concentric ridges. Breadth of a rather wide specimen, 0.84 inch; length of do., about 0.77 inch; convexity, 0.52 inch.

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[*] It is probable d'Orbigny's later name *Spirigera* will be retained for this genus; *Athyris* implying a plain contradiction of fact, since the beak is perforated.

Since publishing a description of this form under the name of *Athyris parvirostris*, in the proceedings of the Philadelphia Academy of Sciences, further comparisons with some additional specimens, lead us to think it most probably only a variety of *A. planosulcata*, of Phillips, to which we now refer it provisionally. Nearly all the specimens we have yet seen, however, differ from the figures, as well as from authentic English examples of Phillips' species, with which we have compared them, in being much less nearly circular, or more nearly subquadrate in outline. Possibly a more extensive series of specimens may prove it entitled to rank as a distinct species, but with our present means of judging, we incline to the opinion that the differences observable, are not of specific value.

None of the specimens we have seen show the projecting, concentric lamellæ of growth so characteristic of the *A. planosulcata*; though as they were all broken from a hard limestone, and seem to have lost the outer layers of the shell, we could scarcely expect any traces of the projecting lamillæ to be retained under such circumstances. Hence their absence is no evidence that they may not have existed.

Locality and position: Keokuk division of Subcarboniferous series; near Warsaw, Illinois.

LAMELLIBRANCHIATA.

GENUS AVICULOPECTEN, McCoy, 1851.

(Ann. Mag. Nat. Hist., vol. vii, p. 171.)

AVICULOPECTEN OWENI, M. and W.

Pl. 18, fig. 2 *a*, 2 *b*, 2 *c*.

Aviculopecten Oweni, MEEK and WORTHEN, Oct., 1860. Proceed. Acad. Nat. Sci., Philadelphia, p. 452.

SHELL small, truncato-subcircular; base regularly rounded; posterior margin rounding from above the middle to the ventral border; anterior side rounded below; hinge equaling about two-thirds the diameter of the valves from the posterior to the anterior side, ranging at right angles to longer axis of the shell. Left valve moderately convex; anterior ear compressed, separated from the swell of the umbo by a rounded, shallow depression, and defined by a shallow sinuosity in the anterior margin; having the form of an inequilateral triangle, the anterior side of which is shorter than either of the others, very slightly rounded at the nearly rectangular extremity; posterior ear a little smaller than the other, compressed, very short, not separated from the margin below by a distinct sinus, terminating in an obtuse angle of about 100°; umbo rather convex, located apparently a little behind the middle of the hinge; surface ornamented by numerous, fine, closely arranged, radiating striæ, which increase by implantation, and are crossed by a few irregular marks of growth. (Right valve unknown.) Diameter from the ventral margin to the hinge, 0.48 inch; do. from the anterior to the posterior margin, 0.50 inch; length of hinge, 0.35 inch. Number of striæ in 0.10 inch near the ventral margin, about 13.

Locality and position: Keokuk division, Subcarboniferous series, near Warsaw, Illinois.

AVICULOPECTEN AMPLUS, M. and W.

Pl. 18, Fig. 4*a*, 4*b*, 4*c*.

Aviculopecten amplus, MEEK and WORTHEN, October, 1860. Proceed. Acad. Nat. Sci., Philad., p. 454.

SHELL large, subcircular, rather thin, not oblique; length and breadth about equal; ventral and lateral margins regularly rounded; hinge line straight, less than the breadth of the shell. Ligament area broad, distinctly striated longitudinally; that of the right valve inclining back from the hinge, and the other overhanging it. Muscular impression large, obliquely subrhombic, concave in outline above, and convex below; located above and behind the middle.

Left valve convex, particularly in the umbonal region; posterior ear very short, nearly rectangular, sometimes very slightly sinuous on the margin, not very distinct from the swell of the umbo; anterior ear subtrigonal, angular at the extremity, and defined by a deep subangular sinus in the margin below—separated from the swell of the umbo by a more or less distinct, rounded sulcus or depression. Beak gibbous, incurved, and extended slightly beyond the hinge margin. Surface ornamented by distinct, narrow, obscurely subnodose, radiating costæ, separated by spaces from five to seven times their own breadth, in which a few much smaller costæ or radiating lines are sometimes seen; crossing the whole are numerous small, irregular concentric wrinkles, and rather obscure lines of growth.

Right valve flat, or concave; posterior ear very small, sometimes obsolete, and in other specimens separated from the mar gin below by a very slight sinuosity; anterior ear oblong, rounded at the extremity, and separated from the margin below by a very profound, acutely angular byssal sinus; umbo entirely obsolete. Surface nearly smooth, or marked with very obscure concentric wrinkles, and faint traces of radiating striæ. In some specimens the anterior ear is ornamented with a few rather distinct radiating plications, crossed by smaller subimbricating marks of growth. Length, 3.63 inches; breadth from the anterior to the posterior margin, about 3.64 inches; convexity of left valve, near 0.70 inch; length of hinge, about 2.48 inches. Some imperfect specimens in the collection measure as much as 5.50 inches in diameter.

In the very distinct inequality of its valves, and the comparatively small size of its posterior ear, as well as in some other characters, this fine species seems to differ from the typical forms of *Aviculopecten*, being in these respects more like *Eumicrotis*. It differs, however, from this group, in possessing a well defined anterior ear, in the left valve, and a ligament area, without any cartilage pit or impression, as well as in having a merely laminated, instead of a prismatic structure.* It is probably related to a shell figured by McCoy, under the name *Malleus orbicularis*, in his *Carb. Foss. Ireland*, pl xix, fig. 2, though clearly distinct specifically. Of course that excellent palæontologist would not now refer such a shell to *Malleus*.

The specimens we have figured are not in a condition to show the muscular impression, but we have indicated its position, form, etc., from others by the dotted line in fig. 4*c*, pl. 18. The left valve, judging from some imperfect specimens before us, is in some individuals proportionally more convex than in that from which our measurements were taken.

It is probable that *Avicula magna*, of Prof. Swallow, described in the *Trans. St. Louis Acad. of Sci.*, vol. ii, p. 98 (1862), is synonymous with this species.

Locality and position: Monroe county, Illinois. Keokuk division of the Subcarboniferous series.

AVICULOPECTEN OBLONGUS, M. and W.

Pl. 18, fig. 3 *a*, 3 *b*.

Avicula oblonga, MEEK and WORTHEN, October, 1860. Proceedings Acad. Nat. Sci., Philad., p. 454.

SHELL small, nearly semicircular, moderately oblique; hinge straight, and longer than any other part of the shell; pallial margin broadly rounded; postero-ventral region more prominent than towards the front. Left valve moderately convex; anterior ear small, compressed, separated from the swell of the umbo by a rounded depression, nearly rectangular, or sometimes defined by a very faint sinuosity in the margin below; posterior ear larger than the other, compressed, but not very distinct from the umbonal slope, extending out into an acute point beyond the posterior margin below, from which it is separated by a broad rounded sinus; beak small, pointed, slightly oblique, incurved, and extending a little beyond the hinge margin; surface ornamented by about twenty-six simple, sharply elevated, linear, radiating costæ, separated at the middle of the valves, by spaces from three to five times their own breadth, and crossed by similar regularly disposed concentric lines, so as to form a rather regular, coarsely cancellated style of ornament. (Right valve unknown.) Diameter, from the hinge to the ventral margin, 0.39; breadth, from the anterior to the posterior side, 0.52 inch; length of hinge, 0.58 inch; convex of left valve, about 0.07 inch.

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* See *American Journal of Science*, xxxvii (second ser.), p. 218, and *Palæont. Upper Missouri*, p. 50, 1865.

In size and general appearance, this species seems to be not unlike *Avicula radiata* of Phillips (*Geol. Yorksh.*, ii, pl. vi, fig. i), though it has its anterior wing much broader, less acutely angular, and not defined by a distinct marginal sinus. Unfortunately, however, Phillips's very brief and unsatisfactory description aids but little in making the comparison.

As we know nothing of the hinge and interior of this shell, we place it provisionally in the genus *Aviculopecten*, to which it most probably belongs.

Locality and position: Warsaw, Illinois; Keokuk group. The geological position of this species was, by an oversight, given as "Warsaw Limestone," in the paper cited at the head of this description.

GASTEROPODA.

GENUS PLEUROTOMARIA, Defrance, 1826.

(Dict. Sci. Nat., vol. xli, p. 381.)

PLEUROTOMARIA SHUMARDI, M. and W.

Pl. 18, fig. 6 *a*, 6 *b*.

Pleurotomaria Shumardi, MEEK and WORTHEN, Oct., 1860. Proceed. Acad. Nat. Sci., Philad., p. 462.

SHELL trochiform, of medium size, very thin; spire moderately elevated, conical, somewhat attenuate at the apex. Volutions about seven, increasing rather rapidly in size, obliquely flattened above; those of the spire somewhat angular near the lower side; last one very prominent, and angular around the middle, moderately convex below, the immediate edge of the angle being truncated by the narrow spiral band. Band flat or slightly concave, and margined above and below by a small, smooth, slightly elevated line; passing around a little above the suture on the whorls of the spire. Suture well defined; umbilicus small; aperture rhombic-subquadrate, wider than high. Surface ornamented by numerous transverse lines, which are very regular and closely arranged on the upper whorls, but become stronger, more distant and less regular, on the last turn. In crossing the upper, flattened, sloping sides of the whorls, these lines arch a little forward, and pass very obliquely backwards from the suture to the band; on the under side of the body whorl, they are smaller or nearly obsolete, and crossed by obscure traces of fine, revolving striæ. Length, 0.70 inch; breadth, 0.73 inch; apical angle rather distinctly concave; divergence, 0.70°.

This handsome species is related to *P. conica*, of Phillips (*Geol. Yorkshire, vol. ii, p.* 288, *pl.* 15, *fig.* 22—1836), but is a smaller shell, and seems never to have had so many whorls. Its volutions are also more flattened, both above and below, and the last one is more angular around the middle; while its aperture is more depressed and angular than in Phillips's species. It likewise differs from that shell in being destitute of a raised line around the upper margin of the whorls, and in having a small, open umbilicus. The specimen we have figured is not in a very good condition to show the surface markings. The specific name was given in honor of Dr. B. F. Shumard, of St. Louis, Mo.

Locality and position: Warsaw, Illinois; Keokuk group, of Subcarboniferous series.

INVERTEBRATE FOSSILS OF THE ST. LOUIS GROUP.

PROTOZOA.

SPONGIÆ.

PETROSPONGIA.

GENUS SPHENOPOTERIUM, M. and W. (See page 145.)

SPHENOPOTERIUM CUNEATUM, M. and W.

Pl. 19, fig. 1*a*, 1*b*, 1*c* and 1*d*.

Sphenopoterium cuneatum, MEEK and WORTHEN, Oct., 1860. Proceed. Acad. Nat. Sci., Philad., p. 448.

COMPRESSED, cuneate, longer than wide; base sharp, a little rounded at the lateral edges. Cells from two or three to about five, rather distant, deep, conical, or a little compressed below, and arranged alternately on each lateral edge; rounded or slightly oval at the aperture, and directed obliquely outwards and upwards; often having one or two slightly prominent ridges extending part of the way up the inside; perforations of the walls numerous and distinct. Surface striæ fine, closely arranged, rather regularly and minutely crenulated; directed obliquely inwards and downwards from the apertures of the cells, and passing more or less nearly parallel to each other, to the base, on the lower flattened portion. Length, 0.75 inch; breadth, 0.50 inch; thickness, 0.22 inch.

This species will be at once distinguished from all of the others yet known, by its more compressed elongated form, and the lateral arrangement of its cells, as well as by the crenulated character of its surface striæ.

Locality and position: Spurgen Hill, Indiana; St. Louis group of Lower Carboniferous series.

RADIATA.

ECHINODERMATA.

CRINOIDEA.

GENUS DICHOCRINUS, Munster. (See page 167.)

Pl. 19, fig. 2 *a*, 2 *b*, 2 *c*.

Dichocrinus constrictus, MEEK and WORTHEN, Sept., 1860. Proceed. Acad. Nat. Sci., Philad., p. 381.

BODY small, oval or obovate, approaching subglobose, rounded above and below, and rather distinctly constricted just below the middle, composed of comparatively thick plates, which are apparently smooth, and joined by linear sutures. Base large, or forming about one-third of the body, twice as wide as high, and more or less concave in the middle of the under side; each of its pieces having five obscure angles above, with very slightly concave margins between, for the reception of the succeeding range of plates; columnar facet very small and round. First radial plates higher than wide, a little unequal, with an oblong-subquadrangular outline; one of them having a fifth very obtuse angle at the middle of the under side; sinus in the upper margin of each, for the reception of the second radials, rounded, rather shallow, and from one-third to one-half the breath of the upper side of each plate. Anal piece slightly larger than the first radials, and like them narrowing and curving inwards at the summit, subpentagonal in outline. (Other parts unknown.) Length to the top of the first radials,

LAMELLIBRANCHIATA.

GENUS AVICULOPECTEN, McCoy, 1851.

(Ann. Mag. Nat. Hist., vol. vii, p. 171.)

AVICULOPECTEN OWENI, M. and W.

Pl. 18, fig. 2 *a*, 2 *b*, 2 *c*.

Aviculopecten Oweni, MEEK and WORTHEN, Oct., 1860. Proceed. Acad. Nat. Sci., Philadelphia, p. 452.

SHELL small, truncato-subcircular; base regularly rounded; posterior margin rounding from above the middle to the ventral border; anterior side rounded below; hinge equaling about two-thirds the diameter of the valves from the posterior to the anterior side, ranging at right angles to longer axis of the shell. Left valve moderately convex; anterior ear compressed, separated from the swell of the umbo by a rounded, shallow depression, and defined by a shallow sinuosity in the anterior margin; having the form of an inequilateral triangle, the anterior side of which is shorter than either of the others, very slightly rounded at the nearly rectangular extremity; posterior ear a little smaller than the other, compressed, very short, not separated from the margin below by a distinct sinus, terminating in an obtuse angle of about 100°; umbo rather convex, located apparently a little behind the middle of the hinge; surface ornamented by numerous, fine, closely arranged, radiating striæ, which increase by implantation, and are crossed by a few irregular marks of growth. (Right valve unknown.) Diameter from the ventral margin to the hinge, 0.48 inch; do. from the anterior to the posterior margin, 0.50 inch; length of hinge, 0.35 inch. Number of striæ in 0.10 inch near the ventral margin, about 13.

Locality and position: Keokuk division, Subcarboniferous series, near Warsaw, Illinois.

Aviculopecten amplus, M. and W.

Pl. 18, Fig. 4*a*, 4*b*, 4*c*.

Aviculopecten amplus, Meek and Worthen, October, 1860. Proceed. Acad. Nat. Sci., Philad., p. 454.

Shell large, subcircular, rather thin, not oblique; length and breadth about equal; ventral and lateral margins regularly rounded; hinge line straight, less than the breadth of the shell. Ligament area broad, distinctly striated longitudinally; that of the right valve inclining back from the hinge, and the other overhanging it. Muscular impression large, obliquely subrhombic, concave in outline above, and convex below; located above and behind the middle.

Left valve convex, particularly in the umbonal region; posterior ear very short, nearly rectangular, sometimes very slightly sinuous on the margin, not very distinct from the swell of the umbo; anterior ear subtrigonal, angular at the extremity, and defined by a deep subangular sinus in the margin below—separated from the swell of the umbo by a more or less distinct, rounded sulcus or depression. Beak gibbous, incurved, and extended slightly beyond the hinge margin. Surface ornamented by distinct, narrow, obscurely subnodose, radiating costæ, separated by spaces from five to seven times their own breadth, in which a few much smaller costæ or radiating lines are sometimes seen; crossing the whole are numerous small, irregular concentric wrinkles, and rather obscure lines of growth.

Right valve flat, or concave; posterior ear very small, sometimes obsolete, and in other specimens separated from the margin below by a very slight sinuosity; anterior ear oblong, rounded at the extremity, and separated from the margin below by a very profound, acutely angular byssal sinus; umbo entirely obsolete. Surface nearly smooth, or marked with very obscure concentric wrinkles, and faint traces of radiating

PLATYCRINUS PENICILLUS, M. and W.

Pl. 19, Fig. 6*a*, 6*b*, 6*c*.

Platycrinus penicillus, MEEK and WORTHEN, Sept., 1860. Proceedings Acad. Nat. Sci., Philad., p. 380.

BODY small, cup-shaped below the arms, a little wider than long, composed of thin plates, connected by moderately distinct sutures, and ornamented by rather distant granules, which show a tendency to range in radiating rows on the first radial plates. Base depressed basin-shaped, considerably wider than high, and broadly truncated, with a small marginal rim below; plates firmly anchylosed. First radial pieces nearly flat, and a little higher than wide, widening somewhat from the base, subquadrangular, the upper angles being slightly truncated by the anal and interradial pieces; sinus in the upper margin, for the reception of the second radial pieces, shallow, and apparently about half as wide as the superior edge. Second radials small, triangular, wider than long, and supporting on their upper concave sloping edges the first divisions of the arms. Anal and interradial pieces unknown.

Arms above the first bifurcation of the second radial pieces, with the two principal divisions subdivided on the second piece, and the two middle branches each bifurcating again on the second piece, beyond which they appear to be all simple, in the only specimen yet obtained. Immediately above the last bifurcations, the arms all consist of single series of pieces, which are alternately longer and shorter on opposite sides; these pieces become shorter and more wedge-shaped above, and gradually pass into a double series of small alternating pieces. The larger single arm-pieces below the bifurcations, and for a short distance above, are generally longer than wide, narrow around the middle, and expanded at each end, the superior lateral angles projecting for the reception of tentacles. All the tentacles are made up of joints two or three times as long as wide. The principal arm-pieces are all connected by peculiar undulating sutures. Column rather strong, and apparently during the life of the animal, very flexible, rounded near the body, and composed of thin, alternately larger and smaller segments, with sharp edges, which are more or less crenulated; farther down becoming alternately compressed in opposite directions, at intervals of about every five joints, while all the joints increase somewhat in thickness, and are ornamented by short spine-like projections. About every fifth segment more prominent on its edges than the others. Length of body, to the summit of the first radials, about 0.20 inch; breadth, 0.26 inch; length of arms, near 1 inch.

This is an exceeding delicate little species, rather closely allied to a form we have seen in collections, labeled *Platycrinus polydactylus*, Troost. It has, however, a smaller body, and the lower joints of its arms are much more distinctly constricted around the middle, and more projecting at the joints on each side.

Locality and position: Hardin county, Ill.; St. Louis division of the Lower Carboniferous series.

PLATYCRINUS PLENUS, M. and W.

Pl. 20, fig. 3.

Platycrinus plenus, MEEK and WORTHEN, Sept., 1860. Proceedings Acad. Nat. Sci., Philad., p. 380.

BODY globose, somewhat wider than high, composed of thin, slightly granulose plates, connected by linear sutures, excepting in the base, where they are anchylosed and carinate. Base depressed basin-shaped, widening rapidly from the rather small columnar facet, which is margined by a small rim. First radials comparatively large, about as high as wide, subquadrangular in outline, the two superior lateral angles being rather distinctly truncated for the reception of the anal and interradial pieces; all regularly incurved above, where they are each provided with a shallow sinus, equaling about half the breadth of the plate. Second radial pieces very small, near half as long as wide, and supporting on their superior sloping concave sides, the first divisions of the arms. Interradial plates comparatively large for a species of this genus, and each provided with a short central spine. Anal plate unknown.

Arms slender, after the first divisions on the small second radials, bifurcating again on the second piece, and above this the two inner branches divide once more on the second piece, making apparently six arms to each ray. All the divisions of the arms, above the last bifurcation, at first composed of a single series of wedge-formed pieces, but gradually passing into double alternating series. Below the bifurcation all the joints are nearly or quite as long as wide, constricted around the middle, and provided with prominent lateral projections at the upper and lower ends; all supporting tentacles, even down to the first pieces above the second radials. Column rather small, compressed, and composed of nearly equal, short segments, near the body. Height, to summit of first radial plates, 0.42 inch; breadth, 0.57; breadth of base, 0.44 inch; height of do., 0.15 inch.

One of the most marked peculiarities of this crinoid, is the globose form of its body, which is distinctly gibbous in the middle, and rounded above, as well as below; its arms are also rather unusually slender in proportion to the size of the body.

Locality and position : Same as last.

GENUS TAXOCRINUS, Phillips.

Synon.—*Poteriocrinus?* and *Cyathocrinus?* (sp.), PHILLIPS, 1836. Geol. Yorksh., part ii; (not Miller, 1821).

Isocrinus, PHILLIPS, 1841. Palæozoic Fossils, p. 30; (not von Meyer, 1837).

Cladocrinus, AUSTIN, 1842. Ann. Mag. Nat. Hist., vol. x; (not Agassiz, 1834).

Taxocrinus, PHILLIPS, 1843. Morris Cat. British Fossils, p. 90; McCoy, 1844, Carb. Fossils, Ireland, p. 178; and 1851, Brit. Pal. Foss., p. 53.

Forbesiocrinus, DE KONINCK and LEHON, 1854. Rech. Crin. Carb., Belgique, p. 118.

Generic formula.—

Basal pieces, 3—small, sometimes nearly hidden by the column.
Subradials, 5—one larger than the others, and of different form.
Radials, 3 to 7 + 5, or varying sometimes in the different rays of the same individual.
Interradials, 0 to 30, or more.
Anal plates, 0 to 30 or 40.
Interaxillary pieces, 0 to 10 (or more) + 5.
Arms variously divided.

BASAL pieces small, and often presenting much the appearance of a thickened terminal piece of the column divided into three parts. Subradials larger, and the one on the anal side generally larger than either of the other four. Primary radial pieces all alternating with the subradials—usually four to each ray, but sometimes three, five, six or seven, the number being, in some instances, different even in the different ray of the same individual. All the primary radial pieces, as well as those of the divisions of the rays, often with a very small supplementary semicircular piece occupying a corresponding excavation at the middle of the upper outer margin of each, and usually anchylosed to the lower margin of the succeeding piece above. Interradial and anal pieces varying, in the typical species, from 0 to 1, 2 or 3 to each space, and in the *Forbesiocrinus* section, from about 7 to 10, 12, 15, etc., on up to 30 or more, to each space. Divisions of the rays in the latter group sometimes soldered together by small, intermediate pieces, so as to form part of the walls of the body, and assume the character of secondary or even Tertiary radials, before giving off the free arms. Vault apparently only covered by a soft integument. Opening of the summit unknown. Column round, generally large near the base, where it is always composed of numerous, very thin pieces. Surface nearly smooth or granular, and always without radiating costæ.

As here defined, this group is made to include species differing greatly in the number of anal and interradial pieces; but as we have elsewhere shown (*Proceed. Acad. Nat. Sci., Philad., Aug.*, 1865, *p.* 138), they agree so exactly in all other known points of structure, and present so many gradations in this character, that we doubt the propriety of making it alone a full generic distinction. It is true, by taking out of the series the species forming the *Onychocrinus* group, which we are now inclined to admit as generically distinct, the gradation from *Taxocrinus* to *Forbesiocrinus* is not so complete as we had supposed; still, when we remember that the typical species of *Taxocrinus* vary in the number of these pieces from none to two or three to each space, and those of *Forbesiocrinus* from seven or eight to thirty or forty, while in the latter group individuals of the same species sometimes present a difference of as many as ten of these pieces to each space, we are still inclined to regard this as merely a subgeneric distinction. Possibly other characters may yet be found for the separation of these groups generically; but until such other distinctions are known to exist, we prefer to range them as sections of the same genus, as follows:

1. **TAXOCRINUS, Phillips (proper).**
   Species without interradial or anal pieces, or with not more than one to three in each space.
   Examples.—*T. macrodactylus* and *T. Egertoni*, Phillips; *T. nuntius*, *T. communis*, and *T. Kellogi*=(*Forbesiocrinus nuntius*, *F. commuis*, etc., Hall.)
2. **FORBESIOCRINUS, de Koninck and Lehon.**
   Species with from seven or eight to thirty or more interradial and anal pieces to each space.
   Examples.—*F. nobilis*, de Koninck and Lehon; *F. Wortheni* and *F. Agassizi*, Hall.

As first proposed by Phillips, the genus *Taxocrinus* included his *Poteriocrinus? Egertoni*, *Cyathocrinus tuberculatus*, Miller, and *C.? macrodactylus* and *C.? nobilis*, Phillips. The first of these, which is a Carboniferous species, and agrees in all respects with this genus, as generally understood, shows, according to Phillips's figure, no interradial pieces, and but a single anal piece. The second species, which is from the Upper Silurian, and is also generally regarded as a typical *Taxocrinus*, shows, according to Murchison's figure (*Siluria, pl.* 14, *figs.* 5 *and* 6), a single interradial piece, resting between the short, superior lateral, truncated side of each two of the first primary radials; while Miller's figure of the same, as reproduced by Pictet (we have not Miller's work at hand), shows on the anal side, apparently two small anal plates, resting side by side down on the short, superior truncated side of one of the subradials. The third species, *T. macrodactylus*, Phillips, also shows, according to his figure (*pl.* xv, *Palæozoic Fossils*), one interradial, while his *T. nobilis* is figured so as to show of these intermediate pieces, one in one space, and three or more in another, and is even supposed by de Koninck and and Lehon to be possibly the same species upon which they proposed to found the genus *Forbesiocrinus*. So that it seems very probable that, as understood by Phillips, his genus *Taxocrinus* may have included both types, though all the species included by him, with possibly the exception of the last one (*T. nobilis*), evidently belong to the genus as restricted by those who admit the genus *Forbesiocrinus*.

As McCoy, however, who first followed Phillips in the use of the generic name *Taxocrinus* (*Carb. Foss. Ireland*, *p.* 178—1844), evidently viewed *T. macrodactylus*, Phillips, as the typical form of the genus, it would, according to the most generally accepted rules of Naturalists, become the type of the genus for all time to come, though it would have made no difference had he regarded any of the others, with possibly the exception of the species *nobilis*, as the type, as they are all true *Taxocrinus*. At the same time, McCoy also included another species (*T. polydactylus*), which, according to his figures and description, appears to have neither anal nor interradial pieces, though it is quite probable it sometimes has one of each. McCoy at that time, however, described the genus as if having five basal pieces directly alternating with five radial series, and the latter forming free arms, without interradial or anal pieces; at least he mentions neither of the latter. But in redescribing this genus in 1851, according to the later improved nomenclature of the parts (*Brit. Pal. Foss.*, *p.* 53), he distinctly states that it has "five hexagonal interradial plates intervening between the second primary radials, resting on the upper lateral edges of the first do;" meaning, as is evident from his specific descriptions, one plate to the anal, and one to each interradial space.

The genus *Forbesiocrinus*, proposed by de Koninck and Lehon, in 1854 (*Rech. Crinoides*, *p.* 18), was founded upon their *F. nobilis*, suspected by them, as above stated, to be the same as *Taxocrinus nobilis*, Phillips. In their description of *Forbesiocrinus*, these authors characterize it as having five basal pieces, directly alternating with five series of primary radials, consisting of four pieces each, with the anal and interradial spaces each occupied by from 12 to 13 pieces, and the axillary spaces by three small pieces each.

From all the descriptions and illustrations yet published, of the groups *Taxocrinus* and *Forbesiocrinus*, it is therefore clearly evident that these two types as understood by European authors, are distinguished by *Taxocrinus* having but one or two ranges of interradial pieces, or none, and *Forbesiocrinus*, from twelve to thirteen of these pieces occupying each interradial space, and a few small pieces in the axillary spaces above. In all other points of structure, and arrangement of parts, whether of the column, basal, radial or arm pieces, they are understood and acknowledged to agree exactly. But as it has been found that typical species of *Forbesiocrinus*, possess three more or less developed basal pieces within or beneath those regarded as such by de Koninck and Lehon (*Iowa Report*, *p.* 628), it might be supposed this character would aid in distinguishing the two groups. It is well known, however, that American typical species of *Taxocrinus*, without interradial or anal pieces, or with but a single range of the two, such as *T. Theimei* and *T. juvenis*=(*Forbesiocrinus Theimei* and *F. juvenis*, Hall, *Jour. Bost. Soc., N. H.*, vii, 317 and 319), possess precisely the same structure, being both described as having small basal and subradial pieces. Nor can we make the presence of interaxillary pieces (which occur in both groups), or the small patelliform supplementary pieces, so often seen at the sutures of the radials and arm-joints in well defined *Forbesiocrinus*, a means of distinction, since they are not always present in otherwise typical forms of that group, with the interradial spaces filled with plates; while well marked species of *Taxocrinus*, such as *T. Thiemei* and *T. juvenis*, Hall (sp.), the first without anal or interradial pieces, and the latter with the "interradial and anal series, consisting of one plate each," are described, the first as having "arm joints showing the small patelloid plates very distinctly," and the latter, with "the small patelloid plates indicated by the strong curvature of the suture lines of the radial plates, becoming more distinct in the arm plates." So if we attempt to distinguish these groups at all, we must fall back upon the difference of the one group being without anals or interradials, or with but one, two, or three ranges of these pieces, and the other with a greater number.

The typical forms of this genus range from the Upper Silurian to the top of the Subcarboniferous; while those belonging to the *Forbesiocrinus* group, are mainly confined to the Subcarboniferous, only a few species apparently of this type having been described from the Devonian rocks.

TAXOCRINUS SEMIOVATUS, M. and W.

Pl. 20, Fig. 4*a*, 4*b*.

Forbesiocrinus? semiovatus MEEK and WORTHEN, Sept., 1860. Proceed. Acad. Nat. Sci., Philad., p. 389.

Taxocrinus semiovatus, MEEK and WORTHEN, Aug., 1865. Proceedings Acad. Nat. Sci., Philad., p. 450.

BODY? below the first bifurcation of the rays, narrow semiovate, a little wider than long, expanding rather rapidly from the column to the summit of the first radial pieces, above which it widens more gradually, or becomes nearly cylindrical; composed of moderately thick, smooth or subgranulose plates, united by linear sutures. Basal plates hidden by the column, or merely forming a narrow ring at the connection of the column with the body. Subradials of moderate size, wider than long, three of them on the anterior side pentagonal, the upper sloping sides being considerably longer than the lateral margins; (the other two unknown). First radial plates on the anterior side, heptagonal, wider than long, the superior truncated edge being longer than either of the others. Second radials smaller than the first, hexagonal, and nearly twice as wide as long. Third and fourth radials smaller than the second, wider than long, and quadrangular or obscurely hexagonal in form, excepting in one of the rays, where there are only four primary pieces, the last of which is pentagonal (or obscurely heptagonal?), and supports the secondary radials. In each of the other two rays seen, there is a fifth radial piece, which appears to be pentagonal, and supports on its superior sloping sides the secondary radial pieces.

A remaining portion of a first interradial piece, in one of the interradial spaces of our specimen, seems to have been pentagonal or hexagonal in form, and rests between the sloping sides of two of the subradial plates, while it connects with a first and second radial on each side. Anal pieces unknown.

Arms, after the first division on the fourth and fifth radials, rounded on the outside, and made up of pieces generally wider than long; one of them, seen in the specimen before us, apparently bifurcating a second time on the sixth piece, and another apparently on the eighth, beyond which they seem to be simple. Minute intercalated semicircular pieces between each two of the primary radials, as well as between the free arm pieces, more or less distinctly developed.

Column comparatively large, and tapering gradually from the base, near which it is made up of extremely thin segments. Central cavity, as seen in a transverse section, comparatively large, and distinctly pentalobate. Height of body, to the top of the first radial pieces, about 0.14 inch; do. from column to the top of the fifth radials, near 0.41 inch; breadth at the summit of the first radials, 0.35 inch; breadth of base, about 0.16 inch.

Locality and position: Hardin county, Illinois; St. Louis division of Lower Carboniferous series.

BLASTOIDEA.

GENUS GRANATOCRINUS, Troost.

Synon.—*Mitra* (sp.), CUMBERLAND, 1826. Reliquiæ Conservatæ, p. 31; (not Lam., 1799).

Pentremites (sp.), Auct.—(not Say).

Granatocrinus, TROOST, 1850. List, Proceed. Am. Ass. Adv. Sci., Cambridge, p. 62, without figures or description; Hall, Fifteenth Ann. Report Regents Univ. N. Y., p. 146; Shumard, 1865, Cat. Pal. Foss., part 1, Crinoidea, p. 375.

Pentatremites (sp.), ROEMER, 1852. Blastoidea, p. 43; Sowerby and others.

BODY globose, oval or elliptic. Pseudo-ambulacral areas like those of the genus *Pentremites*, excepting that they are proportionally narrower, and extend nearly or quite the entire length of the body. Basal pieces three, sunken in a concavity so as not to be visible in a side view. Radial or fork-pieces generally shorter than in *Pentremites*, but otherwise similar; interradials comparatively large, sometimes more than half the length of the body. Anal opening as in *Pentremites*; ovarian? openings intimately connected with the interradials, or sometimes passing directly through the inner end of each of these pieces. Arms and column as in *Pentremites*; surface usually granular, sometimes coarsely so.

The generic formula of this group is exactly the same as that of *Pentremites*, Say, so far as regards the number and arrangement of the pieces forming the body, though the form and proportions of these pieces are so different as to give a very different outline and general physiognomy to the entire fossil. They are therefore readily distinguished from Say's genus, as properly restricted, by their regular oval, elliptical, or subglobose form, concave or less protuberant base, and much narrower and more elongated pseudo-ambulacral areas, which extend the entire length of the body, so as to give it more the appearance of an Echinoid. They likewise present differences in the arrangement of the ovarian? openings of the summit, which are more intimately connected with the interradial pieces, being sometimes excavated, one into each lateral margin of these pieces (*G. Sayi*); or in other instances piercing directly through them, so that each pair appears externally, as a single opening (*G. melo* and *G. Norwoodi*), though they divide into two distinct canals before passing entirely through the plates.* The typical forms of this genus also have the interradial pieces proportionally much larger than in the true *Pentremites*, though this is not a constant character.

In the possession of numerous, extremely slender, thread-like, simple arms, arranged along the pseudo-ambulacral areas, this type also agrees (as might have been inferred from analogy) with the true *Pentremites*, as we know from the examination of a beautiful specimen belonging to Mr. Wachsmuth. This specimen seems to be related to *G. Norwoodi*, as near as can be determined, and shows at least thirty (there are probably more) of these delicate, simple arms, arising from each pseudo-ambulacral area, and extending up so that the lower ones must be quite twice as long as the body. They are all composed of equal joints, about as long as wide. So far as we know, this is the only example of a specimen of this type showing the arms, yet found.

This group is even more nearly similar in general appearance, to *Nucleocrinus*, Conrad=(*Elæacrinus*, Roemer), from which it differs in important points of structure. For instance, in *Nucleocrinus*, we find the area between two of the pseudo-ambulacra on the anal side wider, and often more prominent above than the other interambulacral spaces, and occupied by three large, elongated pieces, the middle one of which, the anal piece, is lanceolate in form, and with the two interradials fills all the large anal area down to the base. On comparing this structure with *Granotocrinus*, the latter is found to differ in having no such three elongated pieces on the anal side; but only a single anal piece differing little from the interradials. So marked a difference as this, in the structure of such simple types, is of course incompatable with generic identity.

As now understood, this genus includes species differing materially in the comparative size of the interradial pieces, the typical species having those pieces very large; while in another section of the genus, represented by such forms as *G. melo* and *G. Norwoodi*, they are as small as in *Pentremites*. There are so many gradations in this character, however, that it does not seem to be possible to make it a means of separating the species into two well defined sections.

This genus is, so far as known, confined to the Subcarboniferous series.

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*In worn or weathered specimens of *G. melo* and *G. Norwoodi*, these little interradial pieces, have been so much eroded as to expose each pair of these openings entirely distinct, when they were really united and appeared as a single opening externally, before wearing.

GRANATOCRINUS CORNUTUS (sp.), M. and W.

Pl. 20, fig. 1.

Pentremites cornutus, MEEK and WORTHEN, October, 1860. Proceedings Acad. Nat. Sci., Philad., p. 141.

Granatocrinus cornutus, SHUMARD, Oct., 1865. Cat. Palæozoic Fossils, part 1, p. 375.

BODY under medium size, subglobose, broader than high, the widest part being at the middle; upper and lower extremities truncated. Base deeply concave; basal pieces entirely within the concavity of the under side. Radial pieces long, or extending from the base of the body to near the summit; narrow, somewhat contracted above and below, and divided by the pseudo-ambulacral areas nearly four-fifths their entire length; all very thick, and rising into prominent carinæ on each side of the pseudo-ambulacral fields. Interradial pieces small for a species of this group, and each projecting out in the form of a very prominent, compressed, horn-like process. Pseudo-ambulacral areas very narrow or lance-linear, and deeply impressed between the very prominent, carinated forks of the radial plates. (Summit unknown.) Height, 0.45 inch; breadth, 0.54 inch; greatest breadth of radial pieces, 0.20 inch; breadth of pseudo-ambulacral areas, 0.04 inch.

This species will be readily distinguished from all the others of this group, yet known, by its prominent, horn-like interradial pieces and its strongly carinated radial plates. These carinæ are so prominent and regular, as to give the whole body the appearance of being divided into ten sharply angular ridges or lobes, extending from near the summit to the base—the intervening depressions at the sutures, and those containing the pseudo-ambulacral areas, being about equal.

Locality and position: Near Mt. Sterling, Brown county, Illinois; St. Louis division of Lower Carboniferous series.

ASTEROIDEA.

GENUS SCHŒNASTER, M. and W.

(σχοινος, a rope; αστηρ, a star.)

Synon.—*Schœnaster* (subgenus *Palasterina*), MEEK and WORTHEN, Oct., 1860. Proceed. Acad. Nat. Sci., Philad., p. 449.

ANIMAL consisting of a flattened pentagonal disc, with the angles more or less produced in the form of rays or arms, and the margins between the rays concave in outline, and fringed with short, flattened, spine-like appendages, which are also continued part of the way out along the lateral margins of the rays. Upper side of rays composed of a number of alternating solid plates, with the dorsal pores passing between them, while the angles between the rays are filled with similar plates, forming the upper side of the disc. Under side of disc composed of numerous small plates, very distinctly imbricating inwards and laterally towards the ambulacra. Ambulacral furrows (in the typical species) wide, deep, with on each side, a single row of comparatively stout, squarish or oblong adambulacral pieces, having an obliquely-outward, imbricating arrangement, so as to present somewhat the appearance of a twisted cord, as seen from below; farther out, these become the marginal pieces of the free rays. There is, however, no regular row of marginal pieces to the disc between the rays. Oral pieces ten, anchylosed? in pairs, so as to look like five pieces merely emarginate at the outer and inner ends. (Other characters unknown.)

Of course it is not possible to give a systematic diagnosis of a genus like this, of which only imperfect fossil species are known. All that can be done, in cases of this kind, is to give such of the more prominent characters as happen to be visible in the particular specimens accessible; while we cannot always be sure, until better specimens are obtained, and other species known, whether some of the characters given may not be merely specific, or in other cases of more than generic importance. At the same time, we have to regret our inability to give any information in regard to some of the more delicate parts that would be the first to claim the attention of the zoologist in describing existing star-fishes.

In first publishing a description of the beautiful species forming the type of this genus, we referred it provisionally to McCoy's genus *Palasterina*, under the subgeneric name *Schœnaster*. Later comparisons, however, have satisfied us that it cannot properly be retained in that genus; and as it seems to present equally important differences from all the other established genera known to us, we now propose to separate it as a distinct genus, under the name *Schœnaster*. It is probably most nearly allied to the Silurian genus, *Palasterina*, but differs in the peculiar oblique, outward, imbricating character of its row of plates on each side of the ambulacral furrows, and the distinct inward imbricating character of the minute, scale-like plates covering the under side of the disc. There are likewise differences in the arrangements of the plates and pores of the dorsal side of the free arms, as seen in our fig. 7 *b*, pl. 19.

As the disc is not seen in the specimen from which fig. 7 *d*, of the plate just alluded to, was drawn, it presents so different an appearance from fig. 7 *a* of the same plate, showing the upper side of the fossil, that, looking at these figures alone, doubts might arise whether or not they belong to the same type. An examination, however, of the upper side of the same specimen from which 7*d* was drawn, as well as of other fragments, show them to be the same. A fragment of the same specimen from which fig. 7*d* was drawn also shows portions of the under side of the disc.

Another species, apparently of this genus, from the Burlington limestone, with much narrower ambulacral furrows,* shows numerous little short, flattened, spine-like appendages protruding from these furrows, with an outward imbricating arrangement or inclination towards the extremities of the rays. There may have been other little spines over the outer surface, in addition to those fringing the margins of the disc, though the specimens retain no traces of them.

SCHŒNASTER FIMBRIATUS, M. and W.

Pl. 19, Fig. 7 *a*, 7 *b*, 7 *c*, 7 *d*.

Palasterina (*Schœnaster*) *fimbriata*, MEEK and WORTHEN, Oct., 1860. Preceed. Acad. Nat. Sci., Philad., p. 449.

BODY regularly pentagonal star-shaped, with the rays produced into rather acutely pointed arms, which are convex above, and about equal in length to the diameter of the disc. Plates of the upper side of the arms and disc, convex, or even tumid; near the disc those of the rays hexagonal, heptagonal, or irregular in form, alternating, and consisting of about five or six longitudinal rows, with a few much smaller intermediate pieces. Farther out the rays, they gradually pass into two mesial ranges of oblong, alternating pieces, with their longer diameter parallel to that of the rays; while on each side of these, minute irregular pieces fill the space between them and the marginal pieces. Towards the extremities of the rays, these little intermediate pieces diminish in size, and at last become obsolete, leaving only the two middle and outer, or adambulacral rows. Ambulacral furrows, in apparently undistorted specimens, deep, and nearly or quite twice as wide as the row of pieces on either side; adambulacral pieces rather thick and strong, and liable to present considerable differences in their obliquity and breadth of surface exposed, in consequence of the compression or distortion of the specimen. Plates of the under side of the disc, very much smaller than the adambulacral, closely crowded together, and owing to their imbricating arrangement, presenting much the appearance of the scales of a fish; immediately on each side of the rays, they imbricate towards the latter, but near the middle of the space between any two ambulacra, the imbrication is inwards towards the mouth, so that in tracing the rows parallel to their longer diameter, across between the rays, they are found to describe a nearly semicircular curve, with a slight angularity near the middle.

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* We should explain here, that the ambulacral furrow of the enlarged ray, represented by fig. 7 *c* of plate 19, is proportionally too broad, in consequence of the accidental flattening of the specimen, and in part to the adambulacral pieces being represented proportionally too small. These furrows are more nearly natural in fig. 7*d*, but even in that specimen they are proportionally wider than in undistorted examples.

Near the extremities of the rays, the dorsal pores are seen to pass between the ends of the two mesial ranges of oblong pieces, but farther in towards the disc, they are more irregularly distributed. Our enlarged figure 7 *b*, pl. 19, represents these pores and the dorsal plates, as seen in one of the rays, with the convex outer portion of the plates ground away, in which condition the pores probably appear larger than natural. In specimens with the tumid portion of these plates unremoved, the pores are not readily seen, and the whole dorsal side then seems to be made up of solid, close-fitting pieces. Greatest diameter across between the extremities of the opposite rays, about 2.37 inches; diameter of disc, 1 inch; breadth of ambulacral furrows, about 0.10 inch; length of little flattened marginal spines, near 0.08 inch.

Locality and position: St. Clair county, Illinois; in the St. Louis division of the Subcarboniferous series.

MOLLUSCA.

BRACHIOPODA.

GENUS PRODUCTUS, Sowerby, 1814.

(Min. Conch., tab. 68.)

PRODUCTUS SCITULUS, M. and W.

Pl. 20, figs. 5*a*, 5*b*, 5*c*, 5*d*.

Productus scitulus, MEEK and WORTHEN, October, 1860. Proceedings Acad. Nat. Sci., Philad., p. 451.

SHELL small, gibbous, wider than long, measuring from the hinge to the anterior curve; hinge line rather more than equaling the breadth of the central part of the valves; anterior side rounded, or sometimes a little flattened along the middle; sides rounding to the front, and straight or somewhat contracted near the ears. Ventral valve very gibbous, and rather strongly arched, moderately produced in front, and presenting but slight indications of a mesial sinus; ears triangular, convex, or somewhat vaulted, sloping up to the convex visceral region, but separated from the swell of the umbo by a rounded depression; umbo convex, incurved, so as to bring its apex apparently a little beyond the hinge line; surface marked by numerous fine, regular, radiating striæ,* about seven or eight of which may be counted in the space of one-tenth of an inch; crossing these, there are, in the visceral region, a few obscure traces of concentric wrinkles. A few scattering bases of spines are also sometimes seen on the ears and anterior slope (in casts). On some specimens, two or three of the striæ on the anterior slope of the ventral valve become more prominent and larger than the others. Dorsal valve unknown. Length, from beak to anterior slope, 0.36 inch; do., from the beak over the curve of the valve, to the anterior margin, 0.45 inch; breadth at the hinge, about 0.45 inch.

The extremely fine striæ, and produced anterior margin of this shell, will at once distinguish it from any other species of its size and general outline, known to us in our rocks.

Locality and position: Alton, Illinois; St. Louis limestone of Lower Carboniferous series.

LAMELLIBRANCHIATA.

GENUS MYALINA, de Koninck, 1844.

(An. Foss. Carb. Belg., p. 125.)

MYALINA CONCENTRICA, M. and W.

Pl. 19, fig. 3*a*, 3 *b*, 3 *c*.

Myalina concentrica, MEEK and WORTHEN, Oct., 1860. Proceed. Acad. Nat. Sci., Philadelphia, p. 456.

SHELL small, thin, compressed, subquadrate, somewhat higher than wide, not very oblique; hinge straight, less than the greatest breadth of the valves below; anterior side a little sinuous, ranging at an angle of about 85° from the hinge; posterior side compressed, its margin nearly straight and parallel with the front above, and rounding into the base below; basal-margin regularly rounded, anterior edges of the two valves rather abruptly inflected towards each other, from the subangular, umbonal slopes; beak of left valve pointed, curving obliquely forward and inward. Surface marked by slender, rather obscure, regularly arranged, concentric lines, separated by smooth spaces some eight or ten times as wide as the lines. Height, 0.75 inch; breadth, 0.59 inch; convexity (of a left valve), about 0.21 inch.

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* Not represented fine and distinct enough in the engravings.

The only specimens of this species yet discovered, so far as we have seen, are left valves, which are rather distinctly compressed for a species of this genus. Its small size, compressed form, and comparatively smooth surface, will serve to distinguish it from all the other species with which we are acquainted.

Locality and position: Spergen Hill, near Salem, Indiana; from the horizon of the St. Louis group of the Lower Carboniferous series.

GENUS YOLDIA, Moller, 1842.

(Kroyer's Nat. Tid., iv, p. 94.)

YOLDIA? LEVISTRIATA, M. and W.

Pl. 20, fig. 7 *a*, 7 *b*.

Leda (*Yoldia?*) *levistriata*, MEEK and WORTHEN, Oct, 1860. Proceed. Acad. Nat. Sci., Philad., p. 457.

SHELL rather under medium size, transversely subovate, moderately convex in the central and anterior regions; base forming a broad, semiovate curve, the most prominent part being a little in advance of the middle; anterior side rounded; posterior side compressed, narrower than the other, and narrowly rounded at the extremity, which appears to be slightly gaping; beaks depressed and located centrally, or a little behind the middle; dorsal outline declining slightly and somewhat concave behind the beaks, a little convex in front; surface apparently smooth, but showing under a good lens extremely fine, regular, closely arranged, concentric striæ. (Hinge and interior unknown.) Length, about 0.60 inch; height, 0.20 inch; convexity, 0.14 inch.

This shell is apparently so very closely allied to *L. subscitula*, of Meek and Hayden (*Trans. Albany Inst., vol. 4—March* 2, 1858), from Kansas, that we would scarcely have ventured to regard it as a new species, were it not for the widely different geological positions occupied by the two shells. The Kansas species, however, is a little more convex, while its dorsal slope behind the beaks is rather more concave in outline. It would probably also present other differences if we had specimens showing the surface markings. As the pallial line has not been seen in either of these species, it is only provisionally that they have been referred to the genus *Yoldia*.

Locality and position: Waterloo, Monroe county, Illinois; upper part of St. Louis group of the Lower Carboniferous series.

GENUS NUCULANA, Link, 1807.

(Rost. Samml., iii, p. 155.)

NUCULANA? CURTA, M. and W.

Pl. 20, fig. 6 *a*, 6 *b*.

Leda curta, MEEK and WORTHEN, June, 1861. Proceed. Acad. Nat. Sci., Philad., p. 144.

SHELL small, ovate, rather gibbous in the central and umbonal regions; anterior side abruptly rounded, the most prominent point being at the middle; base semiovate, more prominent in the antero-ventral region than behind; posterior side abruptly contracted, so as to become subangular at the extremity; beaks elevated, incurved and nearly central; dorsal outline declining rather rapidly from the beaks, the anterior slope being convex, and the posterior slightly concave; posterior umbonal slope prominently rounded, or subangular from the beaks to the narrow anal extremity. Surface ornamented by very regular, closely arranged, concentric striæ, about ten of which may be counted in 0.05 of an inch. (Hinge and interior unknown.) Length, 0.32 inch; height, 0.21 inch; convexity, about 0.19 inch.

This species will be distinguished, at a glance, from the last, by its much shorter and more gibbous form, and coarser concentric striæ, as well as by its angular, posterior, umbonal slopes. As we know nothing of its hinge or interior, it is only placed provisionally in this genus.

Locality and position: Same as last.

GASTEROPODA.

GENUS DENTALIUM, Linnæus, 1758.

(Syst. Nat. Ed., 10, p. 785.)

DENTALIUM VENUSTUM, M. and W.

Pl. 19, fig. 8.

Dentalium venustum, MEEK and WORTHEN, June, 1861. Proceed. Acad. Nat. Sci., Philadelphia, p. 145.

SHELL very slender and slightly tapering, nearly straight, rather thin; section circular; surface smooth. Length, 0.80 inch; diameter of larger end, 0.09 inch; do., at smaller end, 0.03 inch.

It is probable that where the surface of this shell is well preserved very fine striæ of growth could be seen by the aid of a lens, but in all of those we have examined, no traces of surface markings of any kind are visible. It seems to be allied to *D. antiquum*, of Goldfuss (a Devonian species), but is proportionally thinner, and has a smoother surface. From *D. priscum*, of Munster, it differs in being much more slender, and more gradually tapering.

We have before us a few fragments of apparently the same species, but of larger size, from Spergen Hill, Indiana, where they were found associated with the small fossils described by Prof. Hall, from that locality.

Prof. Hall has described, in the Iowa Report, p. 666, a larger, more robust, and more curved species, from Warsaw, Illinois, under the name of *D. primarium*, and gives the Warsaw limestone as its geological position. This, however, is an error, the specimen described by him belongs to one of us (A. H. W.), and is from the Keokuk group, at Warsaw.

Locality and position: Same as preceding.

GENUS STRAPAROLLUS, Montfort, 1810. (See page 158.)

STRAPAROLLUS SIMILIS, M. and W.

Pl. 19, fig. 4 *a*, 4 *b*.

Straparollus similis, MEEK and WORTHEN, June, 1861. Proceedings Acad. Nat. Sci., Philad., p. 145.

SHELL very small, subdiscoidal; spire much depressed; volutions four and a half to five, increasing rather gradually in size, horizontally flattened above from the suture to a moderately distinct revolving angle near the middle of the upper side, thence a little compressed on the upper outer slope, and rather narrowly rounded over the periphery; under side of last turn rounded excepting in the middle, where there is an obtuse, but well defined revolving angle; umbilicus (measuring across from its marginal angle on the middle of the body whorl) once and a half the breadth of the last turn at the aperture, deep, and showing the inner side of all the whorls of the spire; suture well defined; aperture subcircular, or a little modified by the succeeding turn and the flattening on the upper side of the whorls; lip not oblique; surface marked by rather obscure lines of growth. Height of a medium sized specimen, 0.18 inch; breadth, 0.31 inch; diameter of aperture, 0.08 inch.

This delicate little shell seems to be almost an exact miniature of our *S. planodorsatus*, excepting that its spire is a little more elevated, its periphery slightly less regularly rounded, and its umbilicus somewhat smaller. It appears to stand as it were intermediate between that species and our *S. umbilicatus*, being more elevated than the first and less than the last. It is certainly not the young of either of these forms, however, since the largest of our specimens never attain more than one-tenth the size of these shells, and yet have the same number of whorls.

We have before us specimens of a very closely allied form from Spurgen Hill, Indiana, which agree exactly in size and form, excepting that the angles of the whorls are less distinct, and the flattening of the upper side of the whorls is not quite so broad. These, we think, probably belong to the species under consideration, as they differ from any of those described by Professor Hall from that locality, resembling them in other respects, in having a smaller umbilicus, more rapidly enlarging whorls, and a more elevated spire.

Locality and position: Same as preceding.

STRAPAROLLUS SIMILIS, *var.* PLANUS.

Pl. 19, fig. 5 *a*, 5 *b*, 5 *c*.

Straparollus similis, var. *planus*, MEEK and WORTHEN, June, 1861. Proceed. Acad. Nat. Sci., Philad., p. 146.

This form differs from the last in having its spire completely flattened so as to be upon a level with the last turn, and in having a slightly larger umbilicus; while the angle on the under side of the body whorl is a little farther out from the umbilical side. The flattened space on the upper side of its whorls also differs in sloping inwards instead of being horizontal, and its suture seems to be more distinct. Notwithstanding these differences, these forms agree so very nearly in size and other respects, that we do not feel quite warranted in regarding them as distinct species. Should it be thought necessary, however, to separate them specifically, the form under consideration can take as a specific name that by which we have designated it as a variety.

It is an interesting fact that these two forms present exact miniature representations, of the two varieties of *S. pentangulatus*, Sowerby (sp.). The fact, however, that the shells under consideration show all the appearances of mature growth, and never attain more than one-twentieth the size of *S. pentangulatus*, while they have only two or three whorls less, is, we think, sufficient reason for regarding them as distinct.

Locality and position: Same as preceding.

CEPHALOPODA.

GENUS ORTHOCERAS, Auct.

ORTHOCERAS EXPANSUM, M. and W.

Pl. 20, fig. 8 *a*, 8 *b*, 8 *c*.

Orthoceras expansum, MEEK and WORTHEN, Oct., 1860. Proceed. Acad. Nat. Sci., Philad., p. 468.

SHELL having the form of a moderately compressed, rapidly tapering cone; section subcircular, near the smaller end, but more oval towards the larger extremity. Septa concave, and separated near the smaller end by spaces between one-fourth and one-fifth their own greater diameter; the intervals increasing somewhat, but not near in proportion to the expansion of the shell, above. Siphuncle subcentral, small where it passes through the septa, but swelling out into globular cavities between. Surface apparently smooth. Length of a specimen imperfect at both extremities, and entirely septate, 4.30 inches; greater diameter at the larger end, apparently not less than 3.20 inches; do. at smaller end, 0.80. Our specimen being somewhat distorted, the measurement at the larger end cannot be given definitely.

This species seems to be related to *O. dilatatum*, de Koninck (*An. Foss.*, *p.* 515, *pl.* 45, *fig.* 8 *a*, 8 *b*, 8 *c*), but differs in presenting an oval, instead of a circular section, excepting near the smaller extremity; its siphuncle is also more nearly central than is represented in de Koninck's figure 8 *a* and 8 *b*, pl. 45, and differs in its peculiarity of expanding into globular cavities between the septa, as in the group *Actinoceras*. It seems likewise to differ in its surface markings, being nearly smooth; this, however, may be due, at least in part, to the exfoliation of the outer layers of the shell.

Locality and position: McDonough county, Illinois. As the specimen was found loose, its exact geological position is unknown, but it most probably came from the St. Louis group.

INVERTEBRATE FOSSILS OF THE CHESTER GROUP.

RADIATA.

ECHINODERMATA.

CRINOIDEA.

GENUS PTEROTOCRINUS, Lyon and Casseday.

Asterocrinus, LYON, 1857. Geol. Report Ky., vol. iii, p. 472; (not Munster, 1831).
Pterotocrinus, LYON and CASSEDAY, Jan., 1859. Am. Jour. Sci. and Arts, vol. xxix, p. 68.

Generic formula.—
Basal plates, 2.
Radials, 1 or 2+5; the second minute or sometimes wanting.
Secondary radials, 1+10; small, and easily confounded with the brachial pieces.
Anal pieces, 1, known.
Interradials, 4; small probably, sometimes wanting.
Arms, 20.
Interbrachial appendages, 5; very large.

BODY, below the arms, broad and short; truncated, concave, and often rounded below. Base depressed or discoid. First radial pieces much larger than the second; two of them resting upon each of the two basal pieces, and the fifth occupying a more or less defined notch at the anterior end of the suture between the basal pieces, so as to rest partly upon each of the latter. Anal piece in the typical species, small, but in others larger, or nearly or quite equaling the first radials, between two of which it is placed so as to rest upon the basal pieces in a notch at the posterior end of the suture separating the latter. Second radials very minute, or apparently sometimes obsolete; when present occupying a small depression at the middle of the upper side of the first radial pieces. Secondary radial pieces small, and not always readily distinguished from the first brachial pieces—resting either in part or entirely upon the first radials, owing to the minuteness or absence of the second radial pieces; supporting above, the brachial pieces, the inner two of which, however, sometimes rest in part upon the small second primary radial, and the outer two, in part, even down upon the first primary radial. Interradial pieces small or wanting, and not, when present, very distinct from the vault pieces; never more than slightly truncating the superior lateral angles of the first primary radials.

Interbrachial appendages (wing or lobe pieces of Lyon), in the typical species very large, and a rising from between the inner arm-bases; sometimes thin and knife-like, and in other species greatly thickened and bipartite—often nearly equaling the length of the arms, but sometimes shorter, or probably in some species obsolete.

Arms, so far as known, four to each ray, and, excepting at their immediate bases, composed each of a double series of very short alternating pieces, each one of which supports a tentacle; not bifurcating after the divisions at their bases.

Vault, according to Mr. Lyon, composed in the typical species of comparatively few pieces, and having the opening nearly central. In other species apparently falling within this genus, the opening is lateral. Column apparently round.

As remarked in connection with the description of that genus, on page 167, this type is related most nearly to *Dichocrinus*, though it differs in general form, as well as in the structure and arrangement of all the parts above the first radials. It seems to include species constituting two sections or subgenera, the first or typical one of which is characterized by the greatly developed interaxillary appendages (wings of Lyon *), and a central or subcentral opening of the vault, with a small first anal, and short first radial pieces. The other section consists of species with the interaxillary appendages small or wanting, the opening of the summit lateral, and the first anal pieces nearly or quite as large as the first radials. Of the latter group, *Dichocrinus cornigerous*, of Shumard, is an example; it will probably also include *D. sexlobatus*, of Shumard.

It will be observed that the last mentioned section bears somewhat similar relations to the typical species of this genus, that *Pleurocrinus*, of Austin, bears to *Platycrinus*.

All the species of this group known to us, are from the Chester division of the Subcarboniferous series, or near that horizon.

PTEROTOCRINUS CRASSUS, M. and W.

Pl. 23, fig. 2 *a*, 2 *b*.

Dichocrinus (*Pterotocrinus*) *crassus*, MEEK and WORTHEN, Sept., 1860. Proceed. Acad. Nat. Sci , Philad., p. 382.

BODY below the arms basin-shaped, more than twice as wide as high; widening rapidly upwards from the base; composed of thick, apparently smooth plates, connected by linear sutures. Base comparatively large, about four times as wide as high, distinctly concave below, and widening upwards from its rounded lower margin; slightly sinuous at the extremities of the suture; columnar facet round, concave, and about one-fourth as wide as the base. First radial plates broader than long, a little convex, widening regularly upwards from the base, and concave on the upper side, which is longer than either of the others; four of them subquadrangular, with the lateral angles slightly truncated, and one on the anterior side, subpentagonal in consequence of having a fifth obscure angle at the middle of its lower margin. Anal plate as long, and three-fourths as wide, as the first radials, contracted a little above. Second radials very small, rudimentary, or possibly sometimes obsolete, not generally very readily distinguished from the minute secondary radial and first brachial pieces; supporting above, the brachial pieces of the two inner arms, and on their short outer sloping sides, the short inner sides of the two minute secondary radial pieces, which, however, also rest mainly down upon the first radial pieces, and support the two outer arms of each ray.

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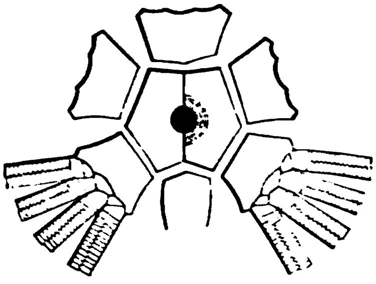
* Mr. Lyon seems to think these appendages were articulated, or movable, so as to have been used in seizing and crushing food. In this view, however, we cannot concur. So far as we have been able to see, these appendages appear to us to be enormously developed vault pieces, analogous to the great spines seen rising from the vault of *Dorycrinus*. In some species they were directed obliquely outwards, and in others they were more erect, but we cannot believe they were movable like the arms.

First two or three arm pieces much larger than the others, closely connected laterally, and consisting of a single range to each arm. Above these they soon pass into double ranges of small, alternating pieces, which are three or four times as wide as long, and bear on their inner sides a double series of tentacles. Arms (of which there are four to each ray, or twenty in the entire series) round on the outer side, and deeply grooved within, slightly tapering, apparently rather long and entirely simple. Tentacles slender, very closely arranged, and composed of joints which are three or four times as long as wide. Interbrachial appendages arising from the middle of each group of arms, thin or knife-like on their outer edges above, much thicker below, and apparently nearly or quite as long as the arms. Height of body to summit of first radials, 0.33 inch; breadth of do. just below the arms, 0.84 inch; breadth of base, 0.60 inch; height of do., 0.16 inch. Breadth of arms, 0.12 inch.

Fig. 29.



Pterotocrinus crassus.—(Nat. size.)

This diagram shows the arrangement of the basal, radial and anal pieces; and in two of the rays, the secondary radials, brachial pieces and commencement of the arms.

This species seems to be related to *P. pyramidalis*, of Lyon and Casseday (*Am. Jour. Sci.*, *2d ser*, *vol.* 29, *p.* 69), but differs in the proportions of the calyx below the arms, its height and breadth being as 84 to 33, while in *P. pyramidalis*, the same measurements are given as 80 to 18. Its first radial plates are also proportionally much higher, and less concave above, judging from Messrs. Lyon and Casseday's description.

Locality and position: Hardin county, Illinois, Chester group; Subcarboniferous.

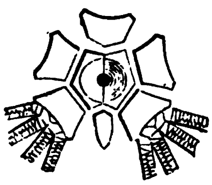
Pterotocrinus chesterensis, M. and W.

Pl. 23, fig. 1*a*, 1*b*, 1*c*.

Dichocrinus (*Pterotocrinus*) *chesterensis*, Meek and Worthen, Sept., 1860. Proceed. Acad. Nat. Sci., Philad., p. 383.

Body below the arms rather small, basin-shaped, or more than twice as wide as high, widening rapidly upwards from the base, the sides being slightly concave in outline; composed of moderately thick, apparently smooth plates, which are connected by linear sutures. Base more than one-third as broad as the body, about three times as wide as high, truncated and concave below; the concavity being margined by an angular rim; columnar facet small, or less than one-third as wide as the truncated under side of the base. First radial plates about the size of the basal pieces, though proportionally higher, twice as wide as long, and widening rather rapidly from below; four of them quadrangular and one on the anterior side pentagonal; all distinctly concave on the upper side (which is longer than either of the others), and having their salient upper lateral angles slightly truncated for the reception of small interradial pieces. Second radial pieces minute or merely rudimentary, triangular, and each partly supporting on its sloping upper edges two larger secondary radial pieces, which also rest with one side directly upon the first primary radials. Secondary radials small, irregularly pentagonal, and bearing upon their upper sloping sides the first brachial pieces, the outer two of which in each ray, likewise have each one edge reposing upon the lateral superior edge of the first primary radial. Anal piece about one-third as wide as each first radial; ovate in form, the upper extremity being very narrow, the lateral margins convex, and its base having an obtuse angle on each side, and one in the middle. Arms (of which there are four to each ray, or twenty in the entire series) simple from their origin, all rounded on the outside, deeply grooved within, and each commencing with a single series of large pieces, but soon passes into a double alternating series of small pieces, bearing two ranges of tentacles. Interradials apparently little larger than the first brachial pieces, and probably wanting between the anal piece and the first radials on each side. (Interbrachial appendages unknown.) Height from base to summit of first radials, 0.16 inch; breadth at the top of first radials, 0.40 inch; breadth of base, 0.24 inch; height of ditto, 0.16 inch; length of anal piece, 0.15 inch; breadth of ditto, 0.09 inch.

Fig. 30.



Pterotocrinus chesterensis.
(Nat. size.)

Diagram showing the structure of the body; and in two of the rays, the minute second primary radials, secondary radials, and brachial and lower arm pieces.

The smaller size and more graceful form of this species, together with its much narrower, angular base, will at once distinguish it from the last. The sides of its body below the arms also differ in being more concave in outline, while its anal piece is more contracted above and its arms more slender.

It is probably nearer *P. pyrimidalis* of Lyon and Casseday, but differs in being much smaller, and in having the margins of its base angular instead of obtusely rounded. It likewise differs in the proportions of its body below the arms, the height and breadth being as 16 to 40, while the same measurements of *P. pyrimidalis* are given as 18 to 80.

Locality and position: Same as last.

ECHINOIDEA.

PERISCHOECHINIDÆ. (See page 225.)

GENUS ARCHÆOCIDARIS, McCoy.

Synon.—*Echinocrinus*,* AGASSIZ, 1841. Monogr. Ech., ii, Introd., p. 15; McCoy, 1844, Carb. Foss. Ireland, p. 173.
Archæocidaris, McCOY, 1844. Ib.
Palæocidaris, DESOR, 1846. Cat. Rais., p. 58.

SPHERICAL or depressed spheroidal. Ambulacra comparatively narrow and composed of two ranges of small pieces, with two pores to each piece. Inter-ambulacral plates large, thin, and each provided with a large, perforated, central tubercle, surrounded at its base by a smooth ring, and rounded at the extremity for the articulation of the primary spines; surrounding the whole is a more or less complete circle of marginal, or submarginal, smaller tubercles, for the articulation of the secondary spines. Apical disc unknown. Mouth surrounded apparently by a membrane, covered by numerous minute, imbricating plates. Jaws strong, trigonal, with a distinct mesial suture. Primary spines large, cylindrical, compressed, or angular, and generally armed with small, oblique, lateral spine-like projections; surface variously ornamented with granules and fine striæ.

This genus is nearly allied to *Eocidaris*, of Desor (*Synop. Ech.*, 1858, *p.* 155), from which, according to him, it is mainly distinguished by the presence of the ring around the base of the primary tubercle of each interambulacral plate. From *Perischodomus*, of McCoy, it is readily distinguished by having a large central tubercle in each of its interambulacral plates, instead of only on those of the marginal rows, on each side of the ambulacra.

Prof. Hall has described a very remarkable type from the Burlington group, under the name *Lepidechinus* (*Descr. New Sp. Crinoidea*, *Prelim. Notice*,

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* The name *Echinocrinus*, which has priority of date for this genus, has probably not been adopted by Palæontologists, because they think it liable to mislead the student in regard to the affinities of these fossils.

Albany, p. 18), which is distinguished by having the interambulacral plates all distinctly imbricating from the dorsal side, and those of the ambulacral series imbricating from below upwards. He places it as a subgenus under *Archæocidaris*, but we should think it generically distinct, if indeed the differences are not of more than generic importance. He says the ambulacral and the interambulacral plates, with the exception of their singular imbricating character, are arranged as in *Archæocidaris;* but by an oversight he omits, both in the subgeneric and specific descriptions, to mention the nature of the tubercles of the interambulacral plates. Judging from some imperfect specimens we have seen, however, that show the remarkable imbricating character of the plates alluded to, and which doubtless belong to *Lepidechinus*, there were apparently no primary tubercles on any of the interambulacral plates of the under side of the fossil, excepting the marginal rows. If this is so, this type is very near *Perischodomus* of McCoy, and may be found to belong to the same group. It is true the imbricating character of the plates is not mentioned in the description of the fossil described by Prof. McCoy, but owing to the fact that only a single very imperfect specimen of it has, we believe, yet been found, this character might have been overlooked.

We have not seen specimens of *Archæocidaris* showing very clearly the number of rows of interambulacral plates. In several specimens we have been able to count four rows, but as these specimens did not show the middle portions of the fossil, it is highly probably there were several additional rows. Judging from analogy, there was probably always an odd number of these plates. As in other types of the suborder, the inner interambulacral plates are hexagonal in form, and the marginal rows pentagonal.

According to Desor, this genus is peculiar to the Carboniferous system. It occurs in both the upper and lower divisions; and in the eastern parts of Kansas, it is found in beds referred by Prof. Swallow to the Permian. The European Permian species originally placed in this genus, are referred by M. Desor to his genus *Eocidaris.*

ARCHÆOCIDARIS MUCRONATA, M. and W.

Pl. 23, Fig. 3*a*, 3*b*, 3*c*.

Archæocidaris mucronata, MEEK and WORTHEN, Sept., 1860. Proceedings Acad. Nat. Sci., Philad., p. 395.

PRIMARY spines long, gradually tapering, slightly compressed or nearly round, and apparently a little curved a short distance above the articulating extremity; articulating end moderately enlarged, and provided with a subangular ring, from which it is abruptly contracted; outer extremity terminating in a mucronate point. Entire surface from about three quarters of an inch above the larger end, armed with rather strong, sharp, but short lateral spinules, which are directed obliquely outwards and upwards. In most cases the surface seems to be entirely smooth, with the exception of the spinules, but by the aid of a magnifier, extremely fine, closely arranged longitudinal striæ may sometimes be seen on well preserved specimens. The articulating end is perforated by a round aperture; and transverse sections show the central cavity to be comparatively large for some distance up.

The only specimens of this species yet obtained consist of detached primary spines, and a few of the interambulacral plates. The latter are wider than long, and apparently nearly smooth, or only ornamented by a single row of small tubercles around the margin; central tubercle prominent, and nearly equaling one-third the greater diameter of the plate, most elevated in the middle, which has a small central pit, and is separated from the surrounding ring by a distinct annular groove. Length of one of the interambulacral plates, about 0.50 inch; breadth of do., 0.35 inch. Length of a primary spine, 2.60 inches; greatest diameter of the same above the articulating end, 0.16 inch; diameter of head, 0.19 inch.

The primary spines of this species present much the appearance of the enlarged figure of *A. Norwoodi*, given by Prof. Hall, on plate 20 of the Iowa Report. They are, however, much more robust, being nearly four times as large as the natural size of the spines of that species, and also differ in being entirely destitute of granules, between the lateral spinules; while their longitudinal striæ are proportionally finer.

Locality and position: Liberty, Randolph county, Illinois; upper part of Chester group.

MOLLUSCA.

BRACHIOPODA.

GENUS PRODUCTUS, Sowerby, 1812.

(Min. Conch., i, p. 153.)

PRODUCTUS PARVUS, M. and W.

Pl. 23, figs. 4*a*, 4*b*, 4*c*, 4*d*, 4*e*.

Productus parvus, MEEK and WORTHEN, October, 1860. Proceedings Acad. Nat. Sci., Philad., p. 450.

SHELL rather small, nearly hemispherical, without any traces of a mesial sinus; length and breadth about equal; hinge equaling the greatest breadth; front rounded; sides intersecting the ears nearly at right angles, sometimes slightly sinuous near the hinge. Ventral valve gibbous, regularly arched, not depressed in the visceral region; beak incurved a little beyond the hinge; ears small, moderately distinct from the swell of the umbo, not flattened. Dorsal valve deeply concave, particularly in the middle and towards the beak. Surface of both valves ornamented by numerous small, rounded, rather closely arranged, occasionally bifurcating striæ, about six of which may be counted in the space of one-tenth of an inch Spines small, erect, apparently confined to the ventral valve, each ear of which supports some seven or eight, while there are usually about three times that number scattered around the lateral and anterior slopes. Sometimes very obscure traces of small concentric wrinkles are indistintly visible near the beak and on the ears, particularly of the ventral valve. Length, 0.54 inch; breadth, 0.55 inch; convexity, 0.38 inch.

This species might be mistaken, at a first glance, for *P. elegans*, of Norwood and Pratten. On comparison, however, it will be found much less produced in front, while the convex part of its ventral valve is not so attenuated towards the beak, which is less prominent. Its hinge line is also more extended, its surface striæ finer and more regular, and its dorsal valve much more deeply concave. This valve likewise always differs in being entirely destitute of the concentric ridge so characteristic of *P. elegans*.

It differs from *P. longispinus*, in always having much finer and more regular striæ, with less distinct concentric wrinkles; while its dorsal valve is uniformly more deeply concave, particularly in the middle.

It is much more closely allied to *Productus Flemingii*, of Sowerby—a variety of *P. longispinus*—than to the typical forms of that species. On comparison, however, with authentic specimens of *P. Flemingii*, sent from Scotland by Mr. Thomas Davidson, we find our shell has the umbo of its ventral valve more ventricose, and more incurved, while its dorsal valve is always more deeply concave, particularly near the beak and in the middle.

Locality and position: Chester, Illinois; Chester group of the Lower Carboniferous series.

GENUS SPIRIFER, Sowerby, 1815.

(Min. Conch., ii, p. 42.)

SUBGENUS MARTINIA, McCoy, 1844.

SPIRIFER GLABER, *var.* CONTRACTUS, M. and W.

Pl. 23, fig. 5*a*, 5*b*.

Conchyliolithus anomites glaber, MARTIN, 1809. Petref. Derb., pl. xlviii, fig. 9, 10.
Spirifer glaber, SOWERBY, 1820. Min. Conch., vol. iii, p. 123, pl. cclxix, fig. 1.
Spirifer obtusus, SOWERBY, 1820. Ibid, fig. 2.
Spirifer oblatus, SOWERBY, 1820. Ibid, pl. cclxviii.
Trigonotreta oblata, BRONN, 1836. Leth. Geog., p. 81, pl. ii, fig. 16.
Spirifera linguifera, PHILLIPS, 1836. Geol. Yorksh., vol. ii, p. 219, pl. x, fig. 4.
Spirifera symmetrica, PHILLIPS, 1836. Ibid, fig. 13.
Spirifera discora? PHILLIPS, 1836. Ibid, fig. 9.
Spirifer lævigatus, VON BUCH, 1840. Mem. Soc. Geol. France, vol. iv, p. 198.
Spirifer obtusus, and *S. oblatus*, McCOY, 1844. Synops. Carb. Foss. Ireland, p. 139.

SHELL rather under medium size, quadrato-subcircular in outline, becoming moderately gibbous with age; length and breadth nearly equal; sides rounded; hinge short, or scarcely equaling half the breadth of the valves near the middle. Dorsal valve much more compressed than the other, most convex along the middle from near the beak to the front, and sloping towards the sides; hinge margin truncated; beak very small, scarcely projecting beyond the hinge line, slightly incurved; area narrow. Dorsal valve gibbous, provided with a narrow, shallow sinus, commencing near the middle and widening to the front, which is a little produced to fill a shallow sub-semicircular sinus in the anterior margin of the opposite valve; beak prominent, incurved, and rather pointed at the extremity; area very much contracted, triangular, more or less arched, and very obscurely defined; foramen rather large, or occupying three-fourths of the small area, having nearly the form of an equilateral triangle and apparently always open to the beak. Surface nearly smooth, or only having obscure marks of growth, and sometimes showing, by the aid of a lens, faint traces of a radiating striæ. Length of largest specimen, 0.90 inch; breadth, 0.86 inch; convexity, 0.60 inch; length of hinge, 0.45 inch.

This shell agrees so nearly with some varieties of *Spirifer glaber*, Martin (sp.), that we have not been able to fully satisfy ourselves that it is specifically distinct, though we strongly suspect that it will prove to be so. In form it is almost exactly like Mr. Davidson's fig. 33, pl. 1*, of his Monograph of the Carboniferous Brachiopoda of Scotland, representing a rather small specimen of Martin's species. It differs, however, from this and all the varieties of *S. glaber* we have seen figured, in having a much smaller and more obscurely defined ventral area. Indeed the sides of the beak of its ventral valve round in so regularly to the foramen, that it is often difficult to see where the margin of the area is. As this character is persistent in the five specimens of different ages that we have seen, we should not hesitate to consider our shell distinct from *S. glaber*, were that species not known to be so extremely variable.

The specimen we have figured is the largest we have seen, the smaller ones being more compressed and more regularly rounded in outline, though none of them are so transverse as the prevailing forms of Martin's species, figured by Mr. Davidson and others.

Locality and position: Chester, and in Pope county, Illinois; Chester group of the Lower Carboniferous series.

LAMELLIBRANCHIATA.

GENUS MYALINA, de Koninck, 1844.

(An. Foss. Carb. Belg., p. 125.)

MYALINA ANGULATA, M. and W.

Pl. 23, fig. 7 *a*, 7 *b*.

Myalina angulata, MEEK and WORTHEN, Oct., 1860. Proceed. Acad. Nat. Sci., Philadelphia, p. 455.

SHELL rather large, obliquely subtrigonal, nearly equivalve, very convex and distinctly angular along the umbonal slopes, cuneate in the posterior and postero-dorsal regions. Anterior margins abruptly inflected from the imbonal angles, so as to meet on a plane at right angles to that of the valves; nearly straight, and sloping obliquely backwards at an angle of about 57° below the horizon of the hinge, to the narrowly rounded basal extremity. Hinge straight, nearly or quite equaling the horizontal length of the shell, and terminating in a rather acute angle behind. Posterior margin forming a broad convex curve from the narrowly rounded base upwards nearly to the hinge, thence curving gracefully outwards to its extremity. Beaks terminal, prominent, or extending above the hinge, incurved, and acutely angular; strongly compressed in front and behind. Surface of cast retaining rather obscure marks of growth. Height, measuring at right angles from the hinge, about 2.55 inches; length, parallel to the hinge, 2.57 inches; length from the beaks, parallel to the umbonal slopes, to the base, about 3.20 inches; convexity of the two valves, near 1.30 inches.

The extremely compressed, prominent beaks, and remarkably convex angular umbonal slopes of this shell, will at once distinguish it from all the other known species of the genus. It is also peculiar in having the posterior extremity of the hinge rather acutely angular, judging from the curve of the lines of growth, in consequence of the sinuate outline of the posterior margin. The compression of the beaks, mentioned above, is not in the direction of the plane of the valves, but from the anterior and posterior sides, in consequence of which their transverse diameter is considerably greater than that at right angles to the same.

Locality and position: Chester, Illinois; Chester group of Lower Carboniferous series.

GENUS SCHIZODUS, King, 1844.

(Ann. and Mag. Nat. Hist., p. 64.)

SCHIZODUS CHESTERENSIS, M. and W.

Pl. 23, fig. 6*a*, 6*b*.

Schizodus chesterensis, MEEK and WORTHEN, Oct., 1865. Proceedings Acad. Nat. Sci., Philad., p. 457.

SHELL rather above medium size, transversely ovate, convex in the anterior and umbonal regions, cuneate posteriorly; anterior side regularly rounded; base forming a broad semiovate curve, being more prominent in the central and anterior regions than behind; posterior side contracted, longer than the other, and narrowly rounded at the extremity; dorsal margin nearly straight, and declining slightly behind the beaks, from which it rounds regularly into the anterior border; beaks gibbous, rather elevated, incurved, and located less than one-third the length of the shell from the anterior margin. Muscular impressions shallow; anterior ones ovate, placed near and a little above the middle of the anterior margin; posterior impressions ovate, located close up under the dorsal margin, between the middle and the anal extremity. Surface marked by fine, regular concentric striæ. Length, of an internal cast, 1.38 inches; height of same, 1 inch; convexity, 0.68 inch.

This species resembles *Schizodus obscurus*, of Sowerby, from the Permian rocks, but is smaller, has less elevated beaks, and differs in having the most prominent part of its posterior extremity above, instead of below the middle. Its concentric striæ are also stronger and more regular. The specimen we have figured is an internal cast, retaining only very obscure traces of these striæ; but others before us have some remaining portions of the shell, on which they are distinctly visible, particularly on the anterior side of the umbones, where they seem to have been most strongly marked. It has more nearly the form of a shell figured by McCoy (*Carb. Foss. of Ireland*, pl. 8, fig. 6), under the name *Anatina attenuata*, but has its beaks more elevated. The form figured by Prof. McCoy is probably a *Schizodus*, at any rate it is almost beyond doubt not an *Anatina*.

Locality and position: Chester, Illinois; Upper part of Chester group, of Lower Carboniferous series.

GASTEROPODA.

GENUS STRAPAROLLUS, Montfort, 1810. (See page 158.)

(Conch. Syst., ii, p. 174.)

STRAPAROLLUS PLANIDORSATUS, M. and W.

Pl. 24, fig. 2*a*, 2*b*, 2*c*.

Euomphalus planidorsatus, MEEK and WORTHEN, Oct., 1860. Proceed. Acad. Nat. Sci., Philad., p. 462.

SHELL of medium size, subdiscoidal; spire nearly flat, or but slightly elevated above the body whorl; volutions about five, increasing gradually in size, flat above, and provided with a moderately distinct revolving angle about two-thirds of the distance across from the inside. From this angle the last whorl is regularly rounded over the periphery to about the middle of the under side, where there is another angle, from which the inner side of the whorl rounds into the umbilicus. Suture well defined. Umbilicus large, deep, and showing about one-half of each inner whorl; aperture subcircular. Surface often scarcely showing any striæ, but in some instances with obscure lines of growth most distinctly seen in the umbilicus. Breadth, 1 inch; height, about 0.30 inch.

This species is evidently closely related to *Eumphalus pentangulatus* of Sowerby (*Min. Con.*, i, p. 97, pl. 45, fig. 1 and 2), but is smaller, and differs in having the angle on the upper side of the whorls located nearer the outer margin. Its periphery is also much less prominently rounded, its whorls less rounded below, and its umbilicus proportionally deeper.

We find these differences particularly in the position of the angle on the upper side of the inner whorls, and the less prominently rounded side of the body whorl in our shell, quite obvious on comparison with authentic specimens of *E. pentangulatus*, from Ireland.

Our species seems to be also very near, if not really identical with a form subsequently described by Prof. Swallow, from the same horizon, under the name *Euomphalus perspectivus* (*Trans. St. Louis Acad.*, *May*, 1862). A drawing, however, of Prof. Swallow's shell, shown one of us by him, represents much stronger marks of growth than we have yet seen on our species.

Locality and position: Thompson's quarry, Randolph county; Chester group of Lower Carboniferous series. Also, in the same position in Saint Genevieve county, Missouri.

GENUS PLEUROTOMARIA, Defrance, 1826.

(Dict. Sci. Nat., xli, tab. 86.)

PLEUROTOMARIA CHESTERENSIS, M. and W.

Pl. 24, fig. 1*a*, 1*b*, 1*c*.

Pleurotomaria chesterensis, MEEK and WORTHEN, October, 1860. Proceed. Acad. Nat. Sci., Philad., p. 460.

SHELL of medium size, turbinate; spire moderately elevated; volutions about six, convex, distinctly carinated around the middle, and flattened or concave above and below the carina, the flattened space above being oblique, and that below vertical; last whorl provided with a second carina below the first, and slightly convex on the under side; suture linear; umbilical perforation small, or nearly closed; aperture subquadrangular, and a little wider than high; spiral band occupying the middle of the vertically flattened space between the two carinæ on the body whorl, and passing around about half-way between the middle and the suture at the base of each of those composing the spire. Surface marked by numerous fine, regular, thread-like revolving lines, crossed by similar striæ, which in traversing the spiral band, make a slight backward curve parallel to the margin of the sinus in the lip. Length, 0.75 inch; breadth, 0.72 inch; apical angle regular, divergence 60°; breadth of spiral band, about 0.04 inch.

This species resembles *P. tabulata*, of Conrad, but is smaller than the average size of that shell, while it differs in having its spiral band located midway between the two carinæ, instead of coincident with the upper angle of the body whorl. It also wants the crenulations on the principal angle, so well marked on that of *P. tabulata*, and is slightly umbilicated, instead of having an imperforate axis, as in Mr. Conrad's species. Again it differs in being much more finely and more regularly cancellated over the entire surface; being in this respect much more like the species we have referred to, *P. Brazoensis*, of Shumard, from which it will be readily distinguished by its other characters.

Locality and position: Chester, Illinois; Chester group of the Lower Carboniferous series.

CEPHALOPODA.

GENUS ORTHOCERAS, Auct.

ORTHOCERAS ANNULATO-COSTATUM, M. and W.

Pl. 24, figs. 3 *a*, 3 *b*.

Orthoceras annulato-costatum, MEEK and WORTHEN, June, 1861. Proceed. Acad. Nat. Sci., Philad., p. 147.

SHELL attaining a medium size, and having the form of an elongated, moderately compressed cone, the sides of which converge towards the apex at an angle of about 14°. Section elliptical, the greater transverse diameter being to the smaller as 100 to 80. Surface ornamented with slightly oblique, annular costæ, which are less than the depressions between, and rather sharply elevated on the smaller half of the shell, but become gradually obsolete towards the aperture, where they are not more widely separated than near the smaller end. Traces of fine transverse striæ are also seen on well preserved specimens, both between and upon the costæ. (Septa and siphuncle unknown.) The largest specimen we have seen is about five inches in length (both extremities being incomplete), and 1.83 inches in its greater diameter at the larger end, while its greater diameter at the smaller end is near 0.70 inch.

This species bears some resemblance to *O. dactyliophorum*, de Koninck (*Ann. Foss. Ter. Carb. Belg.*, p. 518, pl. xlvii, fig. 1, et xlviii, fig 7 *a*, 7 *b*), but differs in being more tapering, and somewhat compressed instead of round. It is also more tapering than *O. annulatum*, of Sowerby. Prof. Swallow has described, from the same horizon as this, a similar species under the name *O. chesterensis* (*Trans. St. Louis Acad. Sci.*, vol. ii, p. 98, 1862), but our shell differs in having fewer and more distant costæ, there being generally about four of them in a space equaling the transverse diameter, while *O. chesterensis* has eight in the same space.

Locality and position: Same as preceding.

GENUS NAUTILUS, Linnæus, 1758.

(Syst. Nat. Ed., 10, t. i, p. 709.)

NAUTILUS GLOBATUS, Sowerby?

Pl. 24, fig. 5 *a*, 5 *b*.

Nautilus globatus, SOWERBY, 1825. Min. Conch., v, pl. 481, fig. 1 and 2.
Nautilus Wrightii, FLEMING, 1828. Brit. Anim., p. 230.
Nautilus bistrialis, PHILLIPS, 1836. Geol. Yorksh., 11, p. 232, pl. 17, fig. 20 and 28.
Nautilus subglobosus, MEEK and WORTHEN, Oct., 1860. Preceed. Acad. Nat. Sci., Philad., p. 469.

SHELL rather under medium size, subglobose, broadly rounded over the dorsum; umbilicus (in internal casts) rather small, deep, and conical, or with nearly vertical sides; volutions about three, increasing rapidly in size, particularly in breadth, deeply embracing, subangular around the margins of the umbilicus on each side; outer chamber forming about half of one volution; septa rather deeply concave, with outer margins nearly straight in passing over the dorsum, where they are separated by spaces a little less than one-fifth their own greater transverse diameter; aperture transversely lunate or reniform; lip deeply sinuous on the dorsal side (not represented quite deep enough in our figure); siphuncle small, central. (Surface unknown.) Greatest diameter, 2.11 inches; height, 1.72 inches; breadth of aperture, 2.06 inches.

At the time we proposed the name *N. subglobosus* for this form, we had not access to Sowerby's figures of his *N. globatus*, but made our comparisons with Prof. de Koninck's figures of a Belgian shell referred by him to Sowerby's species, (*Anim. Foss. Carb. Belg.*, pl. xlvii, fig. 11 *a* and 11 *b*.) From the form represented by Prof. de Koninck, our shell differs so materially, that we could have no doubt in regard to its being specifically distinct, as it expands much more rapidly towards the aperture, and has a smaller umbilicus; while it shows no traces of the transverse ridges or costæ, forming so conspicuous a feature in the figures given by Prof. de Koninck. On comparing our shell with Sowerby's original figures, however, in connection with Prof. McCoy's description of *N. globatus*, we can scarcely doubt the propriety of referring it to that species. The only essential difference seems to be in the size of the siphon, which in our shell is small, while McCoy describes it as being large in *N. globatus* The difference in this character may not, however, be so great as to constitute a reliable specific distinction.

Locality and position: Chester, Illinois; Chester group of the Subcarboniferous series.

NAUTILUS CHESTERENSIS, M. and W.

Pl. 24, fig. 4 *a*, 4 *b*.

Nautilus chesterensis, MEEK and WORTHEN, Oct., 1860. Proceed. Acad. Nat. Sci., Philad., p. 469.

SHELL under medium size, subglobose, rounded over the dorsum and sides; umbilicus (in casts) small and deep, with nearly vertical walls, probably almost closed in adult specimens retaining the shell, apparently showing very little of the inner whorls; volutions about three, increasing moderately in size, deeply embracing, abruptly rounded, or subangular around the umbilicus; septa not very deeply concave, arching slightly forward in crossing over the dorsum, where they are separated by spaces a little less than one-fourth their own transverse diameter; siphuncle very near or quite central; aperture transversely reniform, being modified by the inner whorls. (Surface unknown.) Length or greatest diameter, about 2.46 inches; height, 2.05 inches; breadth near the aperture, 1.70 inches; breadth of umbilicus (in cast), about 0.50 inch.

At a hasty glance this and the last described species might be confounded by a careless observer; but it will be seen by comparison, that the form now before us is much more compressed, and has a smaller umbilicus; while its whorls are proportionally deeper in the direction of the greater diameter of the shell, and not near so angular around the umbilicus on each side.

Locality and position: Same as last.

SUBGENUS ENDOLOBUS, M. and W.

(ενδον, within; λοβος, a lobe.)

(Proceed. Acad. Nat. Sci., Philad., Dec., 1865, p. 259.)

SHELL compressed or subdiscoidal; umbilicus wide and showing all the inner turns; volutions more or less rounded, and without longitudinal furrows or ridges, but slightly embracing; septa bent backward on the inner side, so as to form a kind of funnel-shaped ventral lobe, like we see in *Tretoceras*, excepting that it is not so deep. Siphuncle central, or between the middle and the outer side.

The type of this subgenus differs from other large palæozoic *Nautilii*, with a wide, open umbilicus and merely contiguous or moderately embracing whorls, in having the septa on the inner side bent backwards, so as to form a shallow kind of inner or ventral lobe. It is probable that Montfort's name *Bisiphites*, which was proposed for a large fossil shell, apparently of Carboniferous age, may be synonymous with our *Endolobus*, as he described his type as having two siphons, one nearly central and the other near the inner side, while it would be very easy for such an observer to mistake the lobe we have mentioned for a second siphon, when filled with strony matter. At any rate, that he was mistaken in regard to the existence of two siphons none will doubt. Even in case his type has, however, the internal structure of our shell, we think his name should not be retained, as it implies a direct contradiction of fact.

NAUTILUS (ENDOLOBUS) SPECTABILIS, M. and W.

Pl. 25, fig. 1*a*, 1*b*.

Nautilus spectabilis, MEEK and WORTHEN, October, 1860. Proceedings Acad. Nat. Sci., Philad., p. 469.

Nautilus (*Endolobus*) *peramplus*, MEEK and WORTHEN, December, 1865. Ibid., p. 259.

SHELL attaining a very large size, compressed subglobose; umbilicus rather deep, about as wide as the dorso-ventral diameter of the outer volution, and showing about three-fourths of each inner turn. Whorls three to three and a half, increasing rather rapidly in size, broadly rounded over the dorsal or outer side, and more narrowly round on each lateral margin, where the greatest prominence is a little within the middle; lateral margins each provided with a row of large, broad, depressed or undefined subnodose prominences, about fourteen of which may be counted on each side of the last turn; from these rows of nodes or mammillary protuberances, the inner side of each whorl rounds abruptly into the umbilicus, and is provided along the middle with a moderately deep, rounded concavity for the reception of each succeeding inner turn. Septa deeply concave on the side facing the aperture; separated by intervals measuring on the dorsal side, more than one-third the dorso-ventral diameter of the whorls at the point of measurement, passing nearly straight over the broad periphery, and with a very slight forward curve across the sides; while on the lobed inner concave side they are rather shallow, and more or less funnel-shaped. Siphon placed rather more than its own breadth nearer the inner than outer side. Surface of cast smooth. Greatest diameter, 23 inches; transverse diameter, 12 inches; dorso-ventral diameter of inner whorl, 8 inches; breadth of umbilicus, 8.50 inches; circumference around the periphery, 4 feet, 8 inches.

The specimen from which our figures of this species were drawn, natural size, we now know to be a young shell, or merely the inner whorls of an adult. Owing to the fact that its last septum is broken on the inner side, the lobe is not visible, and it was only after recently breaking one of the volutions across at another septum, that we discovered its existence in this specimen. Hence on the discovery of the great ponderous shell in which this lobe was first discovered, and from which the foregoing description and measurements are given, its specific identity with that figured on plate 25 was not suspected, and another name was proposed for it. As we now know that they argree in this character, and they present no other essential differences aside from mere size, and very slight peculiarities of form, such as are doubtless due to differences of age, we cannot longer regard them as being specifically distinct.

Perhaps this species is most nearly allied to *N. tuberculatus* of Sowerby; at any rate it resembles more nearly Phillips's figure of that species, given in his *Geol. Yorkshire*, vol. i, pl. 29, fig. 29, than any other form with which we are acquainted. It differs, however, in having its whorls broader, and the most prominent part of their sides, with their nodes, placed nearer the umbilicus; while in a profile view it will be at once distinguished by having its periphery prominently rounded, instead of nearly flat. In addition to this, we have no evidence that *N. tuberculatus* has a lobe on the inner side of the septa.

Locality and position: Gravel creek, and other localities in Randolph county, Illinois; Chester division of the Subcarboniferous series.

INVERTEBRATE FOSSILS OF THE COAL MEASURES.

RADIATA.

CRINOIDEA.

GENUS CYATHOCRINUS, Miller, 1821. (See page 175.)

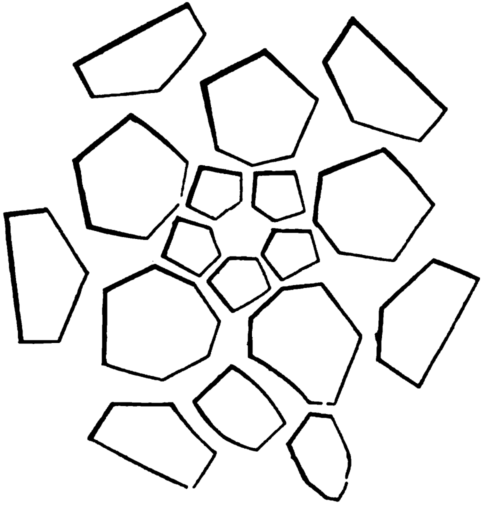
CYATHOCRINUS? SANGAMONENSIS, M. and W.

Pl. 26, fig. 1 *a*, 1 *b*.

Cyathocrinus? sangamonensis, MEEK and WORTHEN, June, 1861. Proceed. Acad. Nat. Sci., Philad., p. 392.

BODY large, semiovate beneath the summit of the first radials, composed of rather thin plates, which are smooth, somewhat convex, and connected by strongly defined, subpunctate sutures. Base moderately prominent, rounded below, pentagonal in outline, and equaling about half the breadth of the body, formed of equal, regularly pentagonal pieces, which are a little wider than long; columnar facet round, deep and about one-third as wide as the base. Subradial pieces large, as wide as long, three of them hexagonal, and two heptagonal, with unequal sides. First radials wider and shorter than the subradial plates, about twice as wide as high, pentagonal, and of nearly equal size and form; the superior side of each horizontally truncated, and considerably longer than either of the basal margins, which are longer than the vertical, lateral edges. First anal plate of moderate size, longer than wide, and projecting somewhat above the summit of the first radials; apparently irregularly heptagonal or octagonal in form, with two or three short sides above, for the reception of smaller pieces, and supported upon the short, truncated, upper side of one of the subradial plates, while on either side it connects with the first radials, excepting on the right inferior sloping margin, which rests against a large, oblong, subanal piece. This latter plate is larger than the true anal piece above, and rests between the superior sloping sides of two of the subradial plates; while its upper oblique side supports one of the inferior sloping sides of the first radial on the right of the anal piece. Upper truncated side of the first radial plates, much thickened within, and provided, near its outer margin, with a distinct, longitudinal furrow, inside of which is a transversely crenulated ridge, with an indentation in the middle; inside of this ridge the margin projects considerably, curves a little upwards, and has a distinct notch or sinus in the middle. Height to the top of first radial pieces on the longer side, about 1 inch; greatest breadth, 1.38 inches; breadth of base, about 0.67 inch; diameter of columnar facet, 0.25 inch.

Fig. 31.



Cyathocrinus sangamonensis. (Nat. size)

This diagram shows basal, subradial, first radial, and anal pieces.

We are in some doubt in regard to the generic relations of this species, not having seen any specimens showing the arms, summit, or any of the radial pieces above the first. It differs from the characteristic species of the genus *Cyathocrinus*, in having a large, subanal plate intercalated between its subradials, and one of the first radial pieces. It also differs in having two of its subradial plates heptagonal in outline, instead of only one, as is usual in that genus. So far as can be determined from our specimen, there seems to be almost, if not quite, as much reason for placing it in the genus *Poteriocrinus*. Yet it differs from the typical species of that genus, in having none of its first radial plates resting directly upon a truncated upper side of one of the subradials, as well as in having but one, instead of two, anal plates between the first radials. We suspect when better specimens are found, showing all its characters, that it may prove to belong to an undescribed genus.' It is not nearly related to any other species with which we are acquainted.

Locality and position: Sugar Creek, Sangamon county, Illinois; upper part of Coal Measures.

GENUS ZEACRINUS, Troost. (See page 185.)

ZEACRINUS DISCUS, M. and W.

Pl. 26, figs. 3*a*, 3*b*.

Zeacrinus discus, MEEK and WORTHEN, September, 1860. Proceedings Acad. Nat. Sci., Philad., p. 390.

BODY, below the summit of the first radial pieces, much depressed, or subdiscoidal, about three times as wide as high, composed of smooth, very slightly convex plates, which are connected by moderately distinct sutures. Base very small, flat and pentagonal; columnar facet equaling about two-thirds the diameter of the base, round, concave, and marked by distinct radiating striæ; perforated by a round, minute, central aperture. Subradial plates extending nearly horizontally outward from the base, so as to form a distinctly pentagonal star-shaped disc, all curving a little upwards towards their outer extremities; three of them pentagonal and two hexagonal, each of the latter having one angle slightly truncated by the anal pieces. First radial plates about twice as large as the subradials, rather more than half as long as wide, pentagonal, and all transversely truncated above, the upper side being longer than either of the others. Second radials and succeeding parts above, unknown.

First anal plate nearly twice as long as wide, pentagonal in form, somewhat wedge-shaped, and deeply inserted between one of the first radials and one of the subradial pieces. Above, it connects on the left with another piece of about its own size, resting upon a short truncated side of one of the subradials, and connecting on the left with one of the first radials, while its upper truncated side supports a third piece, the exact form of which cannot be made out in our specimen. Both of the anal pieces of the second range project more than half their length above the summit of the first radials on each side of them. Height, to the summit of the first radial plates, 0.14 inch; breadth, 0.50 inch; breadth of base, 0.14 inch.

This species appears to be allied to *Cupressocrinus impressus*, of McCoy (*British Pal. Foss.*, pl. 3, D, fig. 2), which is a true *Zeacrinus*, but differs in presenting a subhexagonal instead of a circular outline, as seen from below. It also differs in having a smaller columnar facet, which only conceals a little more than half of each basal plate, while in *Z. impressus* it seems to hide the basal pieces entirely. There are likewise some differences in the arrangement of the anal pieces from those of McCoy's figure, but this is, as we believe, due to his figure having been drawn on the stone without reversing the arrangement of the parts.

Our species seems to be also related to *Zeacrinus mucrospinus*, of McChesney (*New species palæozoic fossils*, p. 10, pl. 4, fig. 7), but it differs in having proportionally much shorter subradial pieces, while the form of its first anal piece is quite different. Its first radials likewise differ in being pentagonal instead of heptagonal. Whether or not its second radial pieces are produced in the form of long spines, as in *Z. mucrospinus*, we are unable to say, not having seen any specimens showing the second radials. From its analogy, however, to the species described by Prof. McChesney, we suspect it will be found to possess similar appendages.

Locality and position: Same as last.

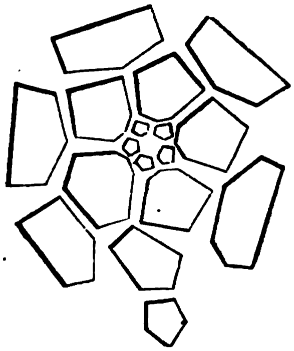
ZEACRINUS? CRASSUS, M. and W.

Pl. 26, fig. 2 *a*, 2 *b*.

Cyathocrinus? crassus, MEEK and WORTHEN, September, 1860. Proceed. Acad. Nat. Sci., Philad., p. 392.

BODY below the summit of the first radial plates, depressed basin-shaped, about twice as wide as high, rounded below, and composed of thick, smooth, somewhat convex plates, which are joined by well defined, subpunctate sutures. Base very small, or about one-fourth the breadth of the body, pentagonal, deeply concave, and apparently nearly hidden by the column. Subradial pieces wider than high, extending at first nearly horizontally outwards from the base, after which they curve upwards; four of them are hexagonal, and one, on the anal side, heptagonal; the angle at the middle of the base of each being very slightly salient. First radial plates larger than the subradials, nearly twice as wide as high, horizontally truncated above, and nearly or quite straight on the upper side, which is longer than the inferior sloping edges; four of them pentagonal, and one, on the left of the anal pieces, hexagonal. First anal piece nearly as large as one of the subradials, pentagonal in form, and resting between the superior sloping sides of two of the subradial plates, while its lateral margins connect with two of the first radial pieces. Second anal piece, about one-third as large as the first, upon the upper, short, truncated side of which it is supported; longer than wide, pentagonal or hexagonal in form, and extending near half its length above the margins of the two first radials, with which it connects on each side. Remaining parts unknown. Height, from base to summit of first radials, 0.45 inch; breadth, 0.92 inch; breadth of base, 0.24 inch.

Fig. 32.



Zeacrinus? crassus.—(Nat. size.) Diagram showing the small basal pieces, the large subradials, first radials, and anal pieces.

This species seems to be closely related, so far as our specimens show its structure, to some of the forms referred by Prof. de Koninck to his genus *Hydreionocrinus* (*Mem. de Palæont., Bull., Acad. Roy. Belgique* (2) tome iii, p. 22). Indeed, if his *H. scoticus*, of that paper, really belongs to that genus, we can scarcely doubt the propriety of calling our species *Hydr. crassus;* but as neither our crinoid nor the species *scoticus* are known to possess the remarkable structure of the upper parts seen in *Hydr. Woodianus*, the type of that genus, we are left in doubt on this point.

Locality and position: Avon, Fulton county, Ill.; lower part of Lower Coal Measures.

Genus ERISOCRINUS, M. and W.

Synon.—A Crinoid near *Encrinus moniliformis*, Marcou, 1864. Bull. Geol. Soc. France, tome xxi.

Erisocrinus, Meek and Worthen, March, 1865. Am. Journal Sci., 2d series, vol. xxxix, p. 174.

Philocrinus, Meek and Worthen, May, 1865. Ibid.; (not de Koninck, 1863.)

Erisocrinus, Meek and Worthen, Aug., 1865. Ibid.; p. 148.

Generic formula.—

Basal pieces, 5.
Subradials, 5. } United to form the walls of the body.
Radials, $5+2$.
Anal and interradials, 0.
Arms and vault unknown.

Basal pieces very small, forming a pentagonal flattened or concave disc, or a low cup. Subradials larger, not varying in form, and all alternating with the basal pieces. First primary radial pieces considerably larger than the subradials, with which they all alternate; all connecting laterally, so as to leave no spaces for anal or interradial pieces, and truncated their entire breadth above for the reception of the next range of pieces. Second radials of near the same size as the first, and like them, connecting all around—supporting on their superior sloping sides the first divisions of each ray.

Of this curious type we only know the body below the summit of the second radial pieces. In the structure of this part of the body, however, it differs from the characters assigned to any known genus of Crinoids (excepting *Cupressocrinus*, from which it differs in other characters to be hereafter mentioned), in having five basal pieces alternating with five subradials, which likewise alternate with the radials, while all these pieces are so connected laterally as to form a cup, without leaving any spaces for anal or interradial pieces. In several respects it closely resembles *Encrinus*, but differs from the descriptions of that genus given by all the authors we have been able to consult, in having a distinct series of subradial pieces between the radial and basal pieces. It also differs from the normal structure of that genus in having but two primary radials in each ray. In a specimen of *Encrinus*, belonging to Smithson's private collection (since destroyed by the fire at the Smithsonian Institution), examined by one of us, in the centre of the cavity occupied by the end of the column, five exceedingly minute rudimentary pieces were visible by the aid of a magnifier within the range generally regarded as the true basal pieces. If these were developed so as to assume the character of true basals, then those usually regarded as such would become subradial pieces, in which case our Crinoid would present no essential difference, unless it may be in the other parts yet unknown. As *Encrinus* is, however, always described as having the radial series resting directly upon the basals, it is exceedingly improbable that the minute points mentioned above were ever developed so as to become properly basal pieces. Hence we are unprepared to admit the existence of the genus *Encrinus* in our Carboniferous rocks, and believe a new genus should be admitted for the form under consideration. It is also highly probable that when we can compare the entire structure of this Carboniferous type with that of *Encrinus*, it will be found to present other important differences.

A fine specimen of *Cupressocrinus abbreviatus* of Goldfuss, from the Eifel, now before us, shows that genus to agree exactly with *Erisocrinus* in the structure of the body up to the second primary radials, above which it differs remarkably in having the rays each composed of a single series of pieces, and soldered together all the way up; while in *Erisocrinus* each ray seems to bifurcate to form free arms on the second radials. *Cupressocrinus* also differs in having a quadrangular central canal running the entire length of the column.

Soon after publishing the description of this genus, we were led by its similarity to a genus described by Prof. de Koninck, under the name *Philocrinus*, from the Carboniferous rocks of India, to believe it identical, and ranged our species under that name. Later comparisons have caused us, however, to doubt the correctness of this conclusion. If there is no mistake in regard to *Philocrinus* being without a range of subradial pieces, then the two types would be clearly distinct. The fact, however, that the basal pieces in *Erisocrinus* are small, and might be easily overlooked in imperfect specimens, taken in connection with the fact that the lowest range of pieces represented in Prof. de Koninck's figure, if true basals, would have to present a singularly elongated cuneiform outline, leads us to suspect there may be another range of small true basal pieces below them, but not visible, from some imperfection in Prof. de Koninck's specimen. If so, then the identity of our Crinoid with his Indian type would be complete. Until this question can be satisfactorily settled, however, we have concluded to retain our name *Erisocrinus* for the American type. Should they prove identical, however, of course Prof. de Koninck's name will have to take precedence, since it has priority of date.

So far as we know, this genus is confined to the Carboniferous rocks. Mr. Marcou thought its close analogy to *Encrinus* indicated that certain Coal Measure rocks in which he found it in Kansas, belong to the part of the Permian series he calls "Dyas." He was, however, at that time, not aware of the fact, that the same species he found in Kansas, and two others of the same genus, occur in the Coal Measures of Illinois, curiously enough at the same time referred by him to the Subcarboniferous.

ERISOCRINUS TYPUS, M. and W.

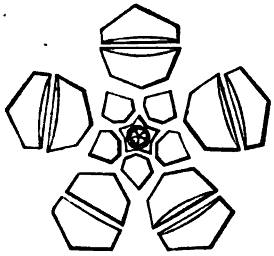
Erisocrinus typus, MEEK and WORTHEN, March, 1865. Am. Jour. Sci., vol. xxix, p. 174.

Philocrinus pelvis, MEEK and WORTHEN, May, 1865. Ib., p. 350.

Erisocrinus nebrascensis, MEEK and WORTHEN, March, 1865. Am. Jour. Sci., vol. xxix, page 174.

BODY below the summit of the radial pieces basin-shaped, rounded below, and obscurely subpentagonal in outline as seen from above or below; composed of thick, smooth, slightly convex plates. Basal pieces small, about half hidden by the column, sometimes sunken, and all pentagonal in form; subradials six or seven times as large as the portion of each basal piece not hid by the column, all equally hexagonal; first radial pieces four or five times as large as the subradials, wider than long, and all equally pentagonal, supporting on their broadly truncated upper edges

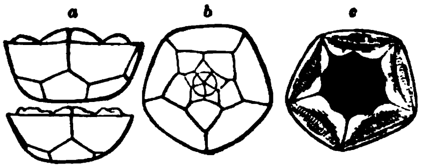
Fig. 33.



Erisocrinus typus.—(Nat. size.) Diagram showing the form and arrangement of the basal, subradial, and first and second radial pieces. (The latter with middle angle too prominent.)

the second primary radials, which are of very nearly the same size and form as the first, but have their sloping sides above, instead of below, while the superior edge of each supports on its upper sloping side the first brachials, or a series of secondary radials, yet unknown. Surface smooth. The foregoing cuts of this species represent it natural size.

Fig. 34.



Erisocrinus typus.—(Nat. size.)

(*a*) Side views; (*b*) view of under side; (*c*) view of upper side; showing the great thickness of the plates, and the articulating surfaces for the reception of the second radials.

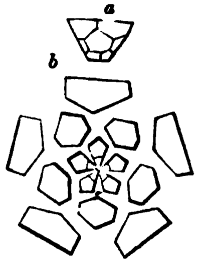
Farther comparisons with some additional specimens, lead us to believe the form from Bellevue, Nebraska, described by us under the name *E. nebrascensis*, is as we at first suspected, but a variety of this species, with a deeper cup, produced by having its subradials proportionally larger.

Locality and position: Coal Measures, near Springfield, Sangamon county, Illinois.

ERISOCRINUS CONOIDEUS, M. and W.

Erisocrinus conoideus, MEEK and WORTHEN, Aug., 1865. Proceed. Acad. Nat. Sci., Philad., p. 150.

Fig. 35.



Erisocrinus conoideus.

(*a*) Nat. size, side view of body. (*b*) Diagram of plates of body, enlarged two diameters.

BODY small, below the summit of the first radials truncate-obconic, nearly twice as wide as high; basal pieces a little wider than long, pentagonal as seen projecting beyond the column, and forming together a small low cup, with diverging sides; subradials near three times as large as the basal pieces, a little wider than long, and all hexagonal; first radial pieces half as long as wide, about twice as large as the subradials, and all broadly truncated on the same horizontal plane above, for the reception of the second radial pieces. Surface smooth; sutures linear, not impressed; plates not convex. Column, and all the parts above the first radial pieces, unknown. Height, to summit of first radials, 0.20 inch; breadth of do., 0.34 inch.

This species will be at once distinguished from young specimens of the last, of its own size, by its obconic, instead of basin-shaped cup. From Professor de Koninck's species *cometa* (in case our species should really belong to his genus), it will be distinguished specifically by the less convex outline of the sloping under sides of its cup, as well as by its shorter and proportionally wider first radial pieces. It will of course have to take the name *Philocrinus conoideus*, in case Professor de Koninck's species should prove generically identical with these American species.

Locality and position: Springfield, Illinois; Upper Coal Measures.

ERISOCRINUS TUBERCULATUS, M. and W.

Erisocrinus tuberculatus, MEEK and WORTHEN, August, 1865. Proceed. Acad. Nat. Sci., Philad., p. 150.

Although we only know this fine species from its detached plates, these agree so exactly in form with the corresponding parts of our *Erisocrinus typus* from the same beds, that scarcely a doubt can be entertained in regard to their belonging to the same genus, while they differ so remarkably in their surface characters as to be distinguished at a glance, specifically, from that or any other Crinoid known in our Coal Measures. This difference consists in their entire external surface being covered with regularly disposed, narrow, prominent tubercles, instead of being smooth.

Of these tubercles there are, on a first radial plate measuring 0.90 inch in breadth, and 0.54 inch in height, about thirty in number, arranged so as to form two rows of about eight each, ranging parallel to the inferior sloping margins, and one row of about eight along the superior margin. Between this latter row and those below, there are usually a few tubercles, either isolated or forming a third transverse row. There is likewise usually one or several others at the lower middle angle outside of the regular rows. This arrangement of the tubercles into rows is not, however, always obvious at a first glance, but a tendency to such a disposition can always be seen.

On the second radials the tubercles are arranged in a single row along the lower and each superior sloping margin, with one or more in the middle between the rows. In the articulating or connecting surfaces of the radial plates, we observe no differences between these pieces and those of the corresponding parts of *E. typus*.

Some of the plates indicate a transverse diameter of 1.40 inch for the entire body.

If our proposed genus *Erisocrinus* is, as we have suspected, identical with *Philocrinus* of Koninck, the name of this species will have to be written *Philocrinus tuberculatus.*

Locality and position: Upper Coal Measures; Sugar creek, Sangamon county, Illinois, and near Brighton, Jersey county, Illinois.

MOLLUSCA.

BRACHIOPODA.

GENUS PRODUCTUS, Sowerby, 1812.

(Min. Conch., i, p. 153.)

PRODUCTUS NANUS, M. and W.

Pl. 26, figs. 4*a*, 4*b*, 4*c*, 4*d*.

Productus nanus, MEEK and WORTHEN, October, 1860. Proceedings Acad. Nat. Sci., Philad., p. 450.

SHELL very small, nearly hemispherical; hinge about equaling the greatest breadth; anterior side regularly rounded, sides intersecting the hinge nearly at right angles. Ventral valve gibbous, without any traces of a mesial sinus; ears triangular, convex and moderately distinct from the swell of the visceral region; umbo ronvex, incurved, and apparently extending slightly beyond the hinge line. Surface ornamented by comparatively large, rounded, radiating costæ, which are rather wider than the grooves between on the convex part of the valve, but suddenly bifurcate, and increase by the intercalation of others, around the anterior and antero-lateral margins; entire surface crossed by numerous very fine concentric striæ; visceral region also marked by moderately distinct, rather regular concentric wrinkles, while the bases of a few scattering spines may be seen on the anterior slope. (Dorsal valve unknown.) Length, 0.37 inch; breadth, 0.44 inch; convexity, 0.25 inch.

This little shell resembles *P. muricatus*, of Norwood and Pratten, but is smaller, and has a more convex ventral valve. It also differs from all the specimens of that species we have seen, in the peculiar sudden bifurcation of its costæ on a somewhat raised band around the free border of its ventral valve.

Mr. Thomas Davidson, of London, the highest authority on the fossil *Brachiopoda*, after examining specimens of *P. wabashensis*, *P. splendens*, and *P. muricatus* (N. and P.), from Illinois, pronounces them almost certainly all identical with *P. longispinus*, of Sowerby; and since we have seen his figures of the varieties of that species in his Monographs of the Carboniferous Brachiopoda of England and Scotland, we are inclined to adopt his opinion. Although none of these varieties agree with the little shell under consideration, we should not be surprised if more extensive collections would bring to light intermediate gradations connecting it with *P. longispinus*, Sowerby.

Our figures 4*a*, 4*b* and 4*c*, of this species, show the divisions of the costæ around the front too fine, and crowded; the enlargement, figure 4*d*, gives a correct idea of their appearance under a magnifier.

Locality and position: Jefferson county, Iowa; Lower Coal Measures.

GENUS SYNTRIELASMA, M. and W.

Synon.—*Choristites (sp.)*, FISCHER, 1825. Programme sur la Choristites.

Terebratula (sp.), d'ORBIGNY, 1842. Voyage dans Amer. Merid., vol. 3, p. 42; (not Miller and others).

Spirifer (sp.), HALL, 1852. Stansbury's Report Exp. to Great Salt Lake, p. 409; (not Sowerby).

Orthis (sp.), SALTER, 1861. Jour. Geol. Soc., London, vol. xvii, p. 64; (not Dalman).

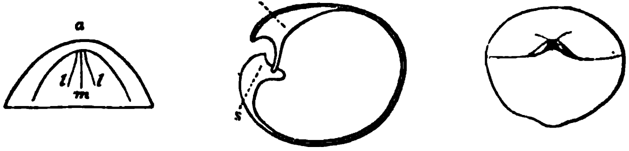
Syntrielasma, MEEK and WORTHEN, Dec., 1865. Proceed. Acad. Nat. Sci., Philad., p. 277.

SHELL thin, gibbous or subglobose, in adult specimens; valves articulated by teeth and sockets, in the typical species nearly equally convex; hinge line straight and very short; area small, partly common to both valves, but higher in the ventral valve, where it is divided by a triangular, open foramen; beaks incurved, subequal. Surface radiately striate, and ornamented with large, radiating plications, which form deeply interlocking, angular projections at their terminations in the margins of the front—one of the plications a little larger than the others on the middle of the dorsal valve, so as to assume somewhat the character of a mesial fold, opposite a corresponding sinus of the other valve.

Socket plates of the dorsal valve much as in *Orthis*, being quite prominent and very diverging, with a linear, longitudinal, mesial ridge between them. Dental laminæ of the ventral valve, thin, prominent, very closely approximate at their connection with the bottom of the valve, and with a similar mesial septum, extending as three nearly parallel plates to the middle of the valve. (Muscular and visceral impressions unknown.) Shell structure distinctly punctate.

The typical species of this group (*Spirifer hemiplicatus*, Hall), has the general external appearance, when well developed, of a subglobose *Orthis*, of the section usually described as resupinate, excepting that it is provided with a few very large plications, one of which forms a mesial fold on the dorsal valve. Internally, however, we observe a marked difference in the nature and arrangement of the dental laminæ, which at their connection with the bottom of the valve, are closely approximate, and with a prominent mesial septum, extended nearly parallel to each other, far forward. The close approximation of these plates, indicates a different arrangement of the cardinal and other muscles, from that of *Orthis*. In the latter genus, slight ridges usually extend forward from the dental laminæ, but so widely separated as to leave a large depression between, for the attachment of the muscles. In the type under consideration, the plates that represent these ridges in *Orthis*, are so close together that it is difficult to understand how any muscles could have been attached to the bottom of the valve between them. This will be better understood when we state that these plates are rarely more than the tenth of an inch apart at their connection with the bottom of the valve, and in some examples, where the shell is as much as nine-tenths of an inch in diameter, the space between these laminæ is no where more than 0.06 of an inch across, and at least one-fourth of this narrow space is occupied by the mesial septum.

Fig. 36.



Syntrielasma hemiplicata.

The above cut, *a*, shows the dental laminæ (*l*, *l*), and mesial septum (*m*), as seen in a section across the beak of the ventral valve. Figure *b*, represents the laminæ (*l*), as seen in a side view; also the socket plates (*s*) in the same way. Fig. (*c*) is an outline posterior view, of a smaller specimen, showing the small area and foramen.

This group will, we think, almost beyond doubt, include two South American shells, described by d'Orbigny, from the Carboniferous rocks of Bolivia, under the names *Terebratula Andii* and *T. Gaudreyi.* Indeed we have some suspicions that his *T. Andii* may even be specifically identical with the type of our group. D'Orbigny's figures appear to represent a more coarsely striated shell than ours, and show the plications extended farther towards the beaks; but Mr. Salter refers to that species, under the name *Orthis Andii*, a shell collected by David Forbes in the Andes (*Quart. Jour. Geol. Soc.*, xvii, p. 64, pl. iv, fig. 3), that agrees almost exactly in form, as well as in the plications, with that before us. It shows, however, no radiating striæ, but they were probably in part obliterated by wearing, for so careful an observer as Mr. Salter would not refer a perfectly smooth shell, to as distinctly striated a species as d'Orbigny's figures represent. We also regard *Choristites Lamarckii*, of Fischer,= *Spirifer Lamarckii*, Murchison, de Verneuil and Keyserling, (*Geol. Russ*, ii, pl. vi., fig. 8*a*, 8 *b*], as most probably another example of this genus. The distinguished authors of the Geology of Russia, were evidently in doubt in regard to the affinities of the last mentioned species, of which they had no perfect specimens, and state that they would have referred it to *Terebratula*, had it not been for the fact that Fischer described it as having a straight hinge, and a triangular foramen.

So far as we know, this genus is strictly confined to the Carboniferous rocks, and includes but few species. It belongs to the *Strophomenidæ*, near *Orthis*.

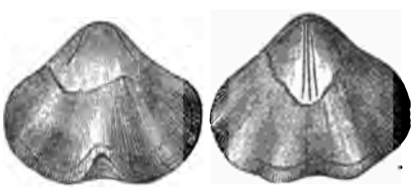
We have not had access to Fischers's work, and consequently do not know what characters he assigned to his proposed genus *Choristites*, nor what species was regarded by him as its type. From the species included under that name by him, however, it seems manifest he intended it for the same group for which Sowerby's older name *Spirifer*, is now retained. We also have the impression that *Spirifer mosquensis* was his typical species of *Choristites*. Should it be the fact, however, that the species *Lamarckii* was the type of his genus, and that it has the internal characters of our genus, it would be necessary to retain his name *Choristites*, for the group under consideration. If so, we shall have no objection to abandoning our name, and calling the American species *Choristites hemiplicatus*, for we shall always yield cheerfully to the law of priority.

SYNTRIELASMA HEMIPLICATA, Hall (sp).

Spirifer hemiplicatus, HALL, 1862. Stansbury's Report Great Salt Lake Exp., p. 409, pl. iv., fig. 3*a*, 3*b*.

SHELL in young examples, moderately convex, and resembling a "resupinate" *Orthis*, in adult specimens often so gibbous that the convexity of the two valves is greater in the middle than the diameter in any other direction. Hinge line only about equaling half the transverse diameter of the valves, and owing to its shortness, and the convexity of the shell, imparting little or no angularity to the lateral slopes at its extremities. Dorsal valve somewhat more convex than the other, and very strongly arched; umbonal region gibbous, and often in adult shells projecting beyond the beak of the opposite valve; beak strongly incurved, so as to bring its apex under the beak and nearly against the area of the other valve; area about half as high as in the other valve, and distinctly incurved with the beak. Ventral valve convex; beak only moderately prominent, and arched or more or less incurved; area small, about one-third as high as wide, not always very distinctly defined, arching with the beak; its triangular foramen scarcely as wide as high. Surface of both valves ornamented with rather fine, regular, crowded radiating striæ, and a few very large radiating plications, never defined on the umbones, but becoming more prominent towards the front, where they terminate in deeply interlocking, angular marginal projections. Of these plications there are two—rarely three—on each side of the slightly larger and more prominent one forming the mesial fold of the dorsal valve; while on the ventral valve there are three—rarely four—on each side of the mesial sinus. A few zigzag marks of growth also traverse the anterior and lateral margins of the valves, parallel to their deeply notched edges. Length of a medium-sized adult specimen, 0.72 inch; breadth of ditto, 0.74 inch; convexity, 0.75 inch. Radiating striæ numbering twelve to fifteen in 0.10 inch.

Fig. 37.



Syntrielasma hemiplicata.

Fig. *a*, dorsal view, natural size, with a part of the shell removed to show the diverging socket plates; fig. *b*, ventral view of same, with a part of shell removed to show the three nearly parallel laminæ, as seen in the internal cast.

It is impossible to confound this interesting shell, for a moment, with any other known form of our entire Palæozoic series. In young examples, as already stated, it is much less convex, and presents somewhat the appearance of an *Orthis*, its plications being at that stage of its growth rounded, very obscure, and only indicated near the front. In larger specimens they are much more prominent, and like the sinuses between, more angular, while the valves are greatly more convex and more arched; the beaks are also, in these larger specimens, more incurved, and the area less apparent.

Worn specimens, or internal casts of adult examples, sometimes resemble some of the small globose species of the genus *Pentamerus*, particularly such species as that described by Professor Hall (*Iowa Report*, vol. i, part ii, p. 514), from the Hamilton group, under the name *P. occidentalis*,* but the more distinct costæ and radiating striæ readily distinguish our shell, where the surface is intact. It is also a resupinate species, so that its dorsal valve corresponds to the ventral, in the *Pentamerus* alluded to.

In examining the striæ under a magnifier, especially on the sides of the valves, we notice that occasionally one of them increases slightly in size for a short distance, to a point where there seems to be a minute opening, as if it had been the base of a tubular hair-like spine. Immediately below each of these the striæ are each slightly less prominent. These little openings are greatly larger and more scattering than the punctures of the substance of the shell, which, however, are comparatively large, scattering, and easily seen with a good pocket lens on exfoliated surfaces.

Locality and position: Twelve miles north of Vandalia, Illinois; Upper Coal Measures. This is the only locality at which this shell has been found in Illinois. It occurs, however, at the same horizon in Eastern Kansas, Northern Missouri and Western Iowa, where it is, as in this State, associated with nearly all the common Upper Coal Measure species of the West.

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* As Prof. Hall had previously applied the name *P. occidentalis* to another species, from Canada, in the second volume of the Palæontology of New York, p. 341, it becomes necessary, in order to prevent confusion, that our Hamilton group species of the West should receive another name. We would therefore propose to call it *Pentamerus galeatiform*, from its resemblance to smooth specimens of *P. galeatus*.

LAMELLIBRANCHIATA.

GENUS AVICULOPECTEN, McCoy, 1852.

(Ann. and Mag. Nat. Hist., vii. p.171.)

AVICULOPECTEN COXANUS, M. and W.

Pl. 26, fig. 6*a*, 6*b*.

Aviculopecten Coxanus, MEEK and WORTHEN, October, 1860. Proceed. Acad. Nat. Sci., Philad., p. 453.

Comp. *Aviculopecten rectilaterarius* (=*Avicula rectilateraria*, Cox), *Kentucky Rep.*, vol. 3, p. 571.

SHELL (left valve) small, extremely thin, compressed, broad subovate exclusive of the ears, very slightly oblique; anterior and posterior margins rounding into the base from below the ears; base regularly rounded; hinge nearly straight, not quite equaling the greatest breadth of the valves below, directed very nearly at right angles to the longer axis of the shell. Anterior ear of moderate size, triangular, the angle at the extremity being a little rounded; flattened so as to be quite distinct from the umbonal slope, and separated from the margin below by a rather abruptly rounded sinus. Posterior ear of nearly the same size as the other, but differing in being acutely pointed at the extremity; flattened, but not so distinct from the umbonal slope as the anterior ear; separated from the posterior margin by a regularly rounded, moderately deep sinus. Beak compressed, scarcely projecting beyond the cardinal margin, and located slightly in advance of the middle of the hinge; umbonal slopes diverging from the beak at an angle of about 77 °. Surface ornamented by small, simple, depressed and rigid costæ, which alternate in size, the smaller ones dying out at various distances between the margin and the umbo; crossing all of these are numerous extremely fine, closely arranged concentric striæ. Right valve unknown. Length, or diameter from the hinge to the basal margin, 0.53 inch; diameter, from the anterior to the posterior margin, 0.51 inch; length of hinge 0.46 inch; convexity of the left valve about 0.05 inch.

In some of its varieties this species seems to approach quite nearly *Aviculopecten recti-laterarius*, Cox, sp., but it is usually a narrower shell, and always differs from the published figure of that species in having its ears more distinct from the umbonal slopes, particularly the anterior one. Its posterior ear also differs in being sinuate instead of straight, and in terminating in an acute point, instead of a right angle.

Some of our specimens are as much as one-third larger than that we have figured, and slightly more oblique, with proportionally larger costæ. These resemble more nearly the shell figured by Prof. Cox, but always differ in having the margin of the posterior ear distinctly sinuous, and its extremity acutely pointed.*

Our species also resembles *Aviculopecten papyraceus*, of Sowerby, but differs in being less oblique, and in having a more obtuse anterior ear, and simple costæ, as well as a smaller and more deeply sinuous posterior ear.

The specific name was given in honor of Prof. E. T. Cox, of the Kentucky and Arkansas Geological Surveys.

Locality and position: Adams county, Illinois, in a dark bituminous shale of the Lower Coal Measures.

AVICULOPECTEN PELLUCIDUS, M. and W.

Pl. 26, fig. 5*a*, 5*b*.

Aviculopecten pellucidus, MEEK and WORTHEN, Oct., 1860. Proceed. Acad. Nat. Sci., Philad., p. 455.

SHELL very small, extremely thin and fragile, compressed, subovate or subcircular, somewhat oblique; hinge margin straight, less than the greatest diameter of the valves from the front to the posterior side; ventral margin nearly regularly rounded; anterior edge rounded near the middle, and passing by a slightly oblique curve into the ventral border; posterior margin most prominent below the middle, sloping obliquely forwards and upwards above. Left valve much compressed; anterior ear rather small, triangular, flattened and distinct from the umbonal slope. Posterior ear of about the same size as the other, flattened and terminating in a rather acute angle; separated from the posterior margin by a broad, very shallow, rounded sinus. Beak compressed, located very nearly at the middle of the hinge. Surface ornamented by very fine, radiating, thread-like striæ, which increase by intercalation and are generally rather smaller than the depressions between; crossing these are equally fine, regular, less distinct concentric striæ. (Right valve unknown.) Diameter from the ventral margin to the hinge, 0.36 inch; breadth from the anterior to the posterior margin, 0.35; length of hinge, 0.23 inch; number of radiating striæ in 0.10 inch at the ventral margin, about 12.

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* In comparing our shell with the figure and description published by Prof. Cox, it is necessary that the reader should bear in mind that he has inadvertently described the *anterior* ear as the *posterior*, and the *posterior* as the *anterior*.

This delicate little shell will be readily distinguished from the last by its smaller size and much finer surface markings, which form a neat cancellated style of ornament. It is also a more oblique shell, with a rather straighter and proportionally shorter hinge, and more angular anterior ear.

Locality and position: Same as preceding.

AVICULOPECTEN KONINCKII, M. and W.

Pl. 26, fig. 8.

Aviculopecten Koninckii, MEEK and WORTHEN, Oct., 1860. Proceed. Acad. Nat. Sci., Philad., p. 453.

SHELL large, thick, truncato-subcircular, rather compressed, wider than long, not oblique, broadly rounded on the pallial margin, and more narrowly rounded on each side below the ears; hinge straight, apparently rather less than the greatest breadth of the valves below, and ranging very nearly at right angles to the vertical axis of the shell; right valve compressed, most convex near the umbo, and flattened towards the free margins; anterior ear having the form of an inequilateral triangle, the anterior side being shorter than either of the others, separated from the margin below by an obtusely angular, or somewhat rounded sinus; posterior ear compressed, longer than the other, and acutely angular at the extremity, separated from the margin below by a nearly rectangular notch; beak compressed, small, and not projecting beyond the hinge margin, located a little in advance of the middle of the hinge; cardinal area inclined over towards the right, and not very wide; surface ornamented by rather small, straight, obscure, depressed, radiating costæ, crossed by nearly obsolete marks of growth. Left valve more convex, and marked by more prominent costæ, which are crossed by much smaller, closely arranged concentric striæ. Ears and beak unknown. Greatest breadth parallel to the hinge a little below the middle, 3.39 inches; height, or diameter from the base to the hinge, about 3 inches; length of hinge, near 3 inches.

This fine species presents some anology, in size and general outline, to *Aviculopecten concavus*, of McCoy, (*Synop. Carb. Foss. Ireland*, tab. 15, fig. 10), but may be readily distinguished by its more pointed posterior ear, and the coarser, as well as more regular costæ of its left valve, which is also a little convex, instead of concave. In our figure, however, the costæ are represented a little too irregular, and too crowded on the posterior ear of the right valve. Usually about eight or nine of the costæ occupy a space of half an inch at the ventral margin of the body of each valve. They seem always to increase by intercalation, the intermediate ones dying out between the free margin and the umbo.

The specific name was given in honor of Prof. L. de Koninck, the distinguished palæontologist of Liege.

Locality and position: Alpine, Iowa; Lower Coal Measures.

AVICULOPECTEN INTERLINEATUS, M. and W.

Pl. 26, figs. 7*a*, 7*b*.

Aviculopecten interlineatus, MEEK and WORTHEN, Oct., 1860. Proceed. Acad. Nat. Sci., Philad., p. 454.

SHELL (left valve) rather small, compressed, broad ovate or subcircular exclusive of the ears, not oblique; length and breadth nearly equal; hinge straight, about equaling the greatest breadth of the valve below, ranging at right angles to the vertical axis of the shell. Base regularly rounded; posterior and anterior margins rounded from below the ears to the base. Anterior ear triangular, flattened so as to be very distinct from the umbonal slope; posterior ear somewhat larger than the other, compressed, triangular, the hinge side being longer than either of the others, rather acutely angular at the extremity. Beak compressed, a little nearer the anterior than the posterior extremity of the hinge; umbonal slopes diverging from the beak at an angle of about 78°; anterior one subangular. Surface ornamented by about fifteen regular, very prominent, slender, and obscurely crenulated, concentric costæ, which are separated by spaces from four to six times their own breadth, excepting on and near the ears; spaces between the costæ occupied by numerous fine, regular, closely arranged concentric striæ, which are crossed by faint indications of radiating ribs. Diameter, from the pallial border to the hinge, 0.60 inch; breadth, from the anterior to the posterior margin, 0.62 inch; convexity, 0.12 inch. Right valve unknown.

This exceedingly beautiful species seems to have varied a little in the details of its surface markings at different ages. In young shells, the regular concentric costæ seem to be nearly or quite smooth, but as the shell advanced in its growth, they gradually assumed an irregularly crenulated outline, and become themselves ornamented with extremely fine longitudinal striæ, not visible without the aid of a lens. These striæ are very much finer and less distinct than those occupying the spaces between the costæ. The faint indications of radiating costæ, seen crossing the concentric striæ in the depressions between the concentric ribs, are also wanting on young shells.

We know of no other species, from either American or foreign localities, nearly allied to this. It is probably the most elaborately ornamented species of the genus known, and may present some corresponding differences in the hinge and interior, that would warrant its separation as the type of a distinct genus.

Locality and position: La Salle, Illinois; Upper Coal Measures, near horizon of coal No. 11.

AVICULOPECTEN OCCIDENTALIS, Shumard?

Pl. 27, figs. 4, 5, 5*a*.

Pecten occidentalis, SHUMARD, 1855. Missouri Geological Report, part ii, p. 207.

Pecten Cleavelandicus, SWALLOW, 1858, Trans. St. Louis Academy Sciences, i, p. 184.

Aviculopecten ——? MEEK and HAYDEN, 1865. Palæontology of the Upper Missouri, p. 50, pl. ii, fig. 10.

SHELL exclusive of the ears, broad subovate or flabelliform; length from beak to ventral margin, slightly greater than the antero-posterior diameter; umbonal margins converging to the beaks at an angle of 80° to 85°; lateral borders rounding into the regularly rounded pallial margin; hinge line nearly or quite equaling the greatest breadth of the valves. Left valve distinctly more convex than the other; ears subequal, the anterior one being slightly shorter, more convex and more obtuse than the other, as well as more distinctly defined by the umbonal angle—sinus separating each from the lateral margins rather shallow, that on the posterior side being more broadly rounded than the other; surface of each ear ornamented by eight to ten or twelve unequal, small radiating costæ, which are crossed by numerous very fine, closely arranged concentric striæ; body of the valve similarly marked, about twelve of the larger costæ reaching the beak, and the smaller intermediate ones dying out at various distances between the beak and the pallial margin; one on the posterior umbonal slope larger and more prominent than any of the others. Right valve nearly flat and much more faintly ribbed than the other, with which it agrees in form, excepting that the byssal sinus under the anterior ear is much deeper and more sharply defined. Cardinal area of moderate breadth, finely striated and inclined over towards the left valve.* Diameter from beaks to ventral margin, 0.80 inch; antero-posterior diameter, 0.73 inch; convexity of the two valves, 0.20 inch.

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* In good casts of the area of this species, we have observed unmistakable evidences of a very shallow, flattened, trigonal cartilage pit. It is unlike that of *Pecten*, however, being quite broad, distinctly triangular and very oblique, more as we see in

This is probably the species described by Dr. Shumard, in the Missouri Report, from the Coal Measures of that State, under the name *Pecten occidentalis*, and subsequently by Prof. Swallow from Kansas, under the name *P. Cleavelandicus*. Apparently the same shell was found by Dr. Hayden, in a hard siliceous rock near the Black Hills, Dakota. It likewise occurs in the Upper Coal Measures of Kansas, where it ranges up into beds containing Permian types.

The engraver was unsuccessful in representing the left valve of this species by figure 5 of our plate. The outline, as there given, is correct, but the costæ are very imperfectly represented. On the shell they are a little flattened, and separated by depressions wider than their own breadth, with usually a smaller one intercalated between each two of the larger, only the latter of which extend up to the beak. Crossing all of these ribs and the depressions between, there are numerous fine, closely arranged concentric striæ, and a few stronger concentric marks of growth, which latter often interrupt or dislocate the costæ towards the free borders. These characters are better seen in our figure 5*a*. One of the ribs on the posterior umbonal slope of the left valve seems to be always larger than any of the others.

Locality and position: Upper Coal Measures; Saline Creek, Gallatin county, Illinois.

GENUS STREBLOPTERIA, McCoy.

Meleagrina (sp.), McCoy, 1844. Carb. Foss. Ireland, p. 80; (not Lam., 1819).

Pecten (sp.), McCoy, 1844. Ib., and others; (not Muller).

Streblopteria, McCoy, 1851. Ann. Mag. Nat. Hist., vii, p. 170, (without type or example); 1855, Brit. Palæozoic Foss., third part, p. 482.

"SHELL ovate or rounded, obliquely extended towards the anterior side; posterior wing broad, undefined, nearly rectangular, extended nearly as far as the posterior margin of the

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Meleagrina. It is traversed by the same fine striæ that mark other parts of the area. One of the most important distinctions between this genus, as generally understood, and all of the modern type of the *Pectinidæ*, is the presence of a distinct, well-defined cartilage pit in the hinge of the latter. The species under consideration, however, shows that there was, sometimes at least, a slight tendency to form a similar cartilage depression in the area of *Aviculopecten*, thus furnishing another evidence of the imperceptible gradations by which all groups will probably be found linked together when we can have an opportunity to compare very large numbers of the living and extinct types.

shell; anterior ear small, deeply defined; surface smooth or radiately ridged; one large, faintly marked, muscular impression a little behind the middle; one short, narrow tooth slightly diverging from the hinge on the posterior side of the beaks; ligament confined to a narrow, simple facet on the hinge margin."

In first publishing the above description in 1851, Prof. McCoy neither figured, described, nor cited any known shell as a type or example of his proposed genus; and it was not until he republished it in 1855, and described under it his *S. lævigata* and *S. pulchella* (previously placed by him in the genus *Meleagrina*), that Palæontologists had the means of knowing definitely what group he had proposed the name for. Hence, we can scarcely regard the genus as having been established, until the date of the latter publication.

The two species just mentioned, were alone placed by Prof. McCoy in this genus, and as the last mentioned one, his *S. pulchella*, seems to be only known from a mere fragment, giving no very satisfactory idea of either its generic or specific characters, his first species, *S. lævigata*, must of course be regarded as the type of the genus. This is a thin, compressed, smooth, Pectenoid shell, with rather short, nearly rectangular ears, a short hinge line, and a very prominently rounded, antero-ventral outline. The latter character, together with the short hinge line, and position of the beaks a little behind the middle of the hinge line, give the valves a rather curious backward obliquity, regarded by Prof. McCoy as a generic character. His figure shows a moderate sinuosity of the anterior margin, under the anterior ear, but as it was drawn from a *left* valve, and he describes the anterior ear as being "deeply defined," we think the genus may probably be found to include a somewhat wider range of forms than its author seems to have intended. Hence we would place here several species that have been referred by Prof. McCoy, and others, to the genus *Pecten*, and have not, at least so strongly marked, the peculiar backward obliquity of the typical species of *Streblopteria* The shells we allude to are smooth, little Carboniferous and Permian species, and seem to have generally, if not always, a deep, sharply defined byssal sinus in the anterior margin of the right valve. It is possible these species may not possess the hinge characters of the type of this genus, but as they certainly do not belong to the genus *Pecten*, as properly restricted to such forms as *P. maximus*, and appear to agree more nearly in general physiognomy with *Streblopteria*, than with *Aviculopecten*, or any of the other eslablished genera, it seems proper to so dispose of them until their affinities can be more clearly determined from specimens showing the hinge and interior. In addition to the following described species, we would thus refer to this genus such forms as *Pecten dissimilis* and *P. consimilis*, McCoy, and *P.*

pusillus, Munster, as well as some of the forms generally referred to *Aviculopecten*. They probably all differ from the latter genus, not only in their truncated, or smaller posterior ear, and greater thinness, but in having no cardinal area, or at least only a merely linear one. Like the typical species of the latter genus, they are doubtless not provided with the cartilage pit, so characteristic of the more modern types of the *Pectinidæ*.

Prof. Winchell, has proposed the name *Pernopecten** (*Proceed. Acad. Nat. Sci. Philad.*, July, 1865, p. 125), for a somewhat similar type. That genus, however, differs in having a central cartilage pit under the beaks, with smaller pits along the hinge on each side, while it wants the deep byssal sinus under the anterior ear of the right valve, seen in *Streblopteria*.

STREBLOPTERIA ? TENUILINEATA, M. and W.

Pl. 26, fig. 9 *a*, 9 *b*.

Pecten tenuilineatus, MEEK and WORTHEN, October, 1860. Proceed. Acad. Nat. Sci., Philad., p. 452.

Compare *P. pusillus*, Schlot., 1816. Akad. Munch., vol. vi, p. 31, pl. vi, fig. 6 *a*, 6 *b*, 6 *c*.

SHELL small, compressed, thin, very nearly equivalve, broadly subovate in outline, with a slight backward obliquity; ventral margin regularly rounded; posterior margin forming a broad gentle curve along the middle and below, and intersecting the hinge above at an angle of about 120 °; anterior margin prominent, rounding regularly from the termination of the produced anterior umbonal slope into the base; hinge line very short, or only about equaling half the antero-posterior diameter of the valves, ranging nearly at right angles to the longer axis of the shell. Posterior ear of both valves nearly obsolete, obliquely truncated, and compressed, but not very distinct from the compressed posterior umbonal slope, nor defined by any marginal sinuosity. Anterior ear rather larger than the other, but not equaling the prominence of the margin below; in the right valve rounded at the extremity, and defined by a deep, sharply cut byssal sinus, from the extremity of which a small sulcus extends obliquely upwards to the anterior side of the beak; in the right valve flattened, broader, and truncated so as to meet the hinge line at an obtuse angle, with but a very slight marginal sinuosity, rather distinct from the oblique anterior umbonal slope. Beaks small, rather compressed, nearly or quite equal, and terminating a little behind the middle of the cardinal margin; anterior umbonal slopes oblique, and more distinct in both valves from the ear, as well as more produced, than the posterior. Surface, to the unassisted eye, apparently smooth, but when examined with a magnifier, seen to be marked with very fine, regular, closely arranged concentric striæ, which, on the anterior ear of the right valve, become suddenly much coarser and more strongly defined. In some instances, the faintest possible traces of something like radiating ribs may be seen on the right valve, in a cross light, under the magnifier. This latter character, however, is rarely visible, and would scarcely ever be observed unless carefully looked for. Diameter, from hinge to pallial margin, 0.57 inch; antero-posterior diameter, 0.53 inch; convexity, 0.10 inch; length of hinge line, 0.27 inch.

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* The type of *Pernopecten*, is *P. cooperensis*=(*Avicula cooperensis*, Shumard,=*Aviculopecten limaformis*, White and Whitfield). The typical specimen of this species figured by Dr. Shumard in the Missouri Report, shows a few obscure, radiating costæ—an exceedingly rare character, though we have occasionally seen faint indications of them on other specimens. Hence Dr. Shumard's species has not been generally identified, and Prof. Hall, in the Iowa Report, p. 522, pl. 7, fig. 9, erroneously refers apparently the same shell to *Avicula circulus*, of Shumard, a quite different species.

This little shell is evidently closely allied to *Pecten pusillus*, Schlotheim, from the European Permian rocks. Compared with Prof. King's figures of that species (*Permian Fossils of England*, pl. xiii, figs. 1, 2, 3 and 4), it differs in having no radiating costæ visible to the unassisted eye, while its anterior outline does not, in the right valve, round so regularly into the byssal notch above. Prof. King's figures of the left valve, which he says are too oblique, differ from that of our shell in having the obliquity in the opposite direction. On comparing Prof. McCoy's description of *P. pusillus* (*Brit. Pal. Foss.*, p. 477) with our shell, we have been struck with its almost exact agreement, and led to suspect that they may prove identical.

Dr. Geinitz has also figured, in his beautiful work on the Permian Fossils of Germany (*Dyas*, pl. xv and xix), under the names *Pecten pusillus* and *P. seri-*

ceus, forms so nearly resembling our shell as to strengthen the suspicion that they may all belong to one species. His fig. 1 *a b*, pl. xv, representing a right and left valve of *P. pusillus*, agree *very* nearly with those before us, excepting that his fig. 1 *a* represents the left valve as having distinct radiating markings on the anterior ear; while his figures of both valves show the beaks a little more prominent. His figures 2 *a b* and 3 *a b*, representing right valves of larger individuals, figured under the name *P. sericeus*=(*Avicula sericea*, de Verneuil), which he regards as identical with *P. pusillus* (sp.), Schlot.,* agree well with the corresponding valve of our shell, except in having the anterior ear narrower, and the sinus under it wider. On plate xix, fig. 23, he gives a figure of a left valve, under the name *P. sericeus*, that shows, though in a less marked degree than some of our specimens, the peculiar backward obliquity that leads us to think these forms may belong to *Streblopteria*.

In making comparisons with our figure 9 *a*, the reader should be informed that the engraver has shaded the posterior ear so as to look too abruptly flattened and distinct from the umbonal region, while the concentric striæ should only be barely indicated, and closely crowded, instead of rather distinctly visible and distant. Some of the specimens have the anterior margin much more prominently rounded than that we have figured, so as to give a greater backward obliquity to the whole outline. This is particularly the case with left valves, in which the anterior oblique umbonal slope is quite distinct from the flattened anterior ear.

Locality and position: South line of Clinton county, Illinois; Upper Coal Measures, near No. 11 coal; associated with *Monopteria longispina*, (*Gervillia* Cox), *Myalina Swallovi*, McChesney, and a large *Myalina*, agreeing with a form figured by Meek and Hayden, in their Upper Missouri Palæontology, p. 33, as *M. subquadrata*, Shumard, var. *ampla*.

GENUS EUMICROTIS, Meek.

Synon.—*Avicula* (sp.), Auct., (not Klein.)
Monotis, King, 1849; Meek & Hayden, 1858; Shumard, 1859; (not Bronn, 1830).
Aucella, McCoy, 1852. Brit. Palæozoic Foss., p. 481; (not Keyserling, 1842).
Eumicrotis, Meek, March, 1864. Am. Jour. Sci., xxxvii, p. 216; Palæontology Upper Missouri, 1865, p. 53.

SHELL suborbicular, plano-convex, the left valve being usually very convex and the right flat, or even a little concave; not distinct auriculate, the ears being nearly obsolete. Beaks central, very slightly oblique, unequal, that of the left valve often elevated, gibbous, and incurved; the other very small, and scarcely extending beyond the hinge line. Hinge short, narrow, edentulous; cartilage pit under the beaks in a somewhat flattened area. Byssal notch or sinus of right valve narrow, deep, and separated from the hinge by a very small rudimentary ear, which does not project beyond the margin. Adductor muscular scar large and subcentral; impressions of retractor muscles, small, and placed near the beaks. Surface generally ornamented with radiating, more or less vaulted or scaly costæ, much more distinctly marked on the left than the right valve.

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* We should have little hesitation in referring the shells figured by Dr. Geinitz, to *P. pusillus*, but judging from de Verneuil's single figure of his *Avicula sericea*, we should, like that gentleman, have regarded it as an entirely distinct species.

This genus has been frequently referred to *Monotis* of Bronn, an entirely distinct Jurassic or Triassic genus, from which it was separated by one of the writers in 1864. It differs completely, in form and general physiognomy, from the type of Bronn's genus (*Monotis Salinaria*), in being very inequivalve or planoconvex, not at all or very slightly oblique, and particularly in being always provided with a very deep, sharply defined byssal sinus under the beak of the right valve.* It is more nearly allied, as stated by the author, in proposing the genus, to Keyserling's genus *Aucella*, to which Prof. McCoy referred one of the typical species in 1852; but it differs from that Jurassic group in being much less oblique, more inequivalve, and provided with radiating costæ, as well as in possessing a distinct cartilage pit under the beak. The latter character has led Prof. King to suppose it more nearly allied to the *Pectinidæ;* but as was shown by the author, in founding the genus, its shell presents, under the microscope, the prismatic structure of the *Pteriidæ* (=*Aviculidæ*), and not the structure characterizing the *Pectinidæ.*

In Europe this group is generally regarded as not dating back farther than to the Permian period, but in this country we find species of it in rocks that cannot be separated in any way from our Coal Measures.

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* The absence of any traces of a byssal sinus in the type of the genus *Monotis*, would seem to indicate a difference in the habits of the species of that group, from those of *Eumicrotis*, which, judging from their strongly defined byssal notch, were during life habitually attached by a byssus.

EUMICROTIS HAWNI *var.* SINUATA, M. and W.

Pl. 27, figs. 12, 12 *a*, 12 *b*, 13 and 14.

Monotis Hawni, MEEK and HAYDEN. Trans. Albany Inst., iv, March 2, 1858.

Eumicrotis Hawni, MEEK. Am. Jour. Sci., xxxvi, March, 1864, p. 216; Meek and Hayden, Palæont. Upper Missouri, 1865, p. 54.

SHELL oval-suborbicular, plano-convex, not oblique; ventral margin rounded in outline; posterior side obliquely truncated above; anterior side somewhat obliquely straightened above, or rounding regularly from below the ear to the base; cardinal margin shorter than the greatest transverse diameter of the valves; hinge area moderately broad, and distinctly inclined over towards the left valve; cartilage pit distinct, rather broad, and placed directly under the beaks, being common to both valves. Left valve ventricose, umbo not oblique, incurved and projecting a little above the cardinal margin; posterior ear little developed and obliquely truncated; anterior ear slightly longer, rounded at the extremity, and separated from the anterior margin by a deep, well defined, angular sinus; surface ornamented with more or less waved or distorted radiating costæ, of unequal size, there being generally one, two or three smaller ones between each two of the larger—all crossed by concentric, imbricating lamillæ of growth, which on the larger ribs rise in the form of vaulted subspiniferous scales. Right valve flat, or very nearly so; beak obsolete; byssal sinus very narrow and deep; muscular impression subovate, oblique and placed a little behind the middle; surface much more obscurely costate than that of the left valve. Diameter from hinge to basal margin, 1.25 inch; antero-posterior diameter, 1.12 inches; convexity, about 0.35 inch.

Although we have placed this as a variety of *E. Hawni*, we are much inclined to believe it will prove to be a distinct species, since it differs from all the Kansas specimens of that shell we have seen, in having a rather distinct sinus in the anterior margin of the left valve, as well as in the truncated outline of its posterior margin. In its surface markings it seems to agree exactly with that species, as well as with the European *E. speluncaria*. From the latter, however, it differs much more widely in form than from *E. Hawni*; while the muscular impression of its right valve is much narrower than that of *E. speluncaria*, as figured by Prof. King.

The specimens of this form under examination, show very distinctly the cast of the cartilage pit, which is deepest in the left valve, the beak of which curves directly over it. (See cast of this pit represented by a prominence under the beak in fig. 13.) It differs from the cartilage pit in *Avicula*, in not being in the slightest degree oblique. One of the writers, in proposing this genus, upon some Kansas specimens, was unable to verify Prof. King's description of the nature of the cartilage pit, but the specimens now before us confirm Prof. King's statement exactly, and there can be little doubt that the presence of this pit is a constant character in this genus.

Locality and position: Bridge of north branch Saline river, Gallatin county, Illinois; Upper Coal Measures.

GENUS PTERINEA, Goldfuss, 1833.

(Petref. Germ., ii, p. 133.)

SUBGENUS MONOPTERIA, M. and W., 1866.

(*μονος*, solitary; *πτερον*, a wing—in allusion to its single wing.)

Synon.—*Gervillia*, Cox, 1857. Kentucky Geol. Rep., vol. 3, p. 568; (not Defrance, 1820.)
Monopteria, MEEK and WORTHEN, 1866. Proceed. Chicago Acad. Nat. Sci., vol. i, p. 20.

SHELL aviculoid, obliquely produced and angular posteriorly, and rounded in front; subequivalve, both valves being convex. Posterior wing slender and produced, anterior one obsolete or merely represented by a very small ear-like appendage drawn back between the beaks in a deep lunule, so as not to be seen in a side view, exactly as in the Silurian type *Amphicœlia*, Hall.* Anterior margins without a byssal emargination in either valve, but apparently a little gaping in the lunule, just under the small rudimentary ear. Muscular impressions very faintly marked. Cardinal area rather narrow, and provided with but few longitudinal cartilage furrows. Hinge edentulous.

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* *Amphicœlia*, Hall, was proposed as a subgenus under *Leptodomus*, to which it is not nearly allied. It evidently belongs to the *Aviculidæ*, near *Pterinea*, though apparently generically distinct.

This type differs from the typical species of *Pterinea*, not only in form and general physiognomy, but in its edentulous hinge, and very obscurely marked or obsolete, anterior muscular impression. It will be readily distinguished from *Gervillia*, to which the typical species was referred by Prof. Cox, in the Kentucky Geological Report, by being entirely without any traces of the transverse cartilage pits characterizing that genus, and indeed of the entire subfamily to which it belongs.

Whether or not this group should be made to include such forms as *Gervillia lunulata* and *G. laminosa*, Phillips (*Geol. Yorksh.*, ii, pl. vi.), which have a well developed, distinctly projecting, lobe-like anterior ear, we have no means of determining, until those forms have been more fully characterized. That they are true Gervillias, however, is exceedingly improbable.

PTERINEA (MONOPTERIA) GIBBOSA, M. and W.

Pl. 27, figs. 11, 11*a*, 11*b*.

Pterinea (*Monopteria*) *gibbosa*, MEEK and WORTHEN, June, 1866. Proceed. Chicago Acad. Sci., p. 20.

SHELL irregularly suborbicular, moderately gibbous; anterior outline from a little below the middle, forming with the base a more or less regular semicircular curve, and sometimes obliquely truncated, with slightly concave outline in the region of the lunule from the beaks above. Posterior basal margin a little sinuous; posterior extremity attenuate and angular; umbonal ridge rather prominent from near the back part of the beak to the produced posterior extremity of each valve; beaks equal, scarcely projecting above the cardinal margin, and as it were, drawn some distance back of the prominently rounded front. Anterior margins just in front of and under the beaks, abruptly inflected to form the deep lunule; anterior ear minute, rounded and placed very close up under or between the beaks. Hinge line straight, less than the entire length of the shell, owing to the prominence of the front below the beaks. Cardinal area with three or four linear, longitudinal cartilage furrows, one of which seems to have been deeper and wider than the others near the beaks. Posterior wing slender, rather compressed, and extending at least as far back as the extremity of the valves below, from which it is separated by a very profound, rounded sinus. Surface only marked by fine concentric striæ of growth. Length, about 1.05 inches; height 0.86 inch; convexity, 0.52 inch.

This species is related to *P.* (*Monopteria*) *longispina* (= *Gervillia longispina*, Cox, Kentucky Geological Report, vol. 3, pl. viii, fig. 6), but differs in being much less oblique, in having its anterior margin much more prominently rounded beyond its beaks, which are set farther back, as well as in having the posterior extremity of its valves much less produced. Judging from Prof. Cox's figure, his species would seem to also have stronger marks of growth than our shell, but we have seen specimens of a form from the Coal Measures of Clinton county, of this State, agreeing well with Prof. Cox's figure in other respects, that presented an almost entirely smooth surface.

Gervillia auricula, Stevens (*Am. Jour. Sci.*, vol. xxv, March, 1858, p. 265), evidently belongs to this group, and seems to us to be identical with that described by Prof. Cox, under the name *G. longispina.*

Locality and position: Saline creek, Gallatin county, Illinois; from a ferruginous sandy seam in shale, apparently, judging from the affinities of its fossils, holding a position near or above the horizon of the eleventh bed of coal, in the Kentucky section of the Coal Measures.

GENUS MYALINA, deKoninck, 1844.

(Ann. Foss. Belg., p. 125,)

MYALINA SWALLOVI, McChesney.

Pl. 27, fig. 1, 1*a*, 1*b*, 1*c*, 1*d*.

Myalina Swallovi, McCHESNEY, 1860. New species Palæozoic Fossils, p. 57; also, pl. 2, fig. 6*a*, 6*b*, Illustrations of same, 1865.

SHELL small, oblique, very nearly equivalve, gibbous along the umbonal slopes, and presenting almost exactly the outline of a *Modiola*. Anterior margin sinuous, but not gaping in the middle, and forming a kind of lobe above in front of the beaks and umbonal ridges; beaks compressed, small, very oblique, not quite terminal, depressed; umbonal ridge prominent, extending from the beaks obliquely backwards and downwards in advance of the middle of the valves, gradually dying out at the anterior ventral margin; hinge line equaling at least half the entire length of the valves, straight, but passing into the posterior margin without forming a perceptible angle; posterior side compressed, cuneate, and forming in outline a graceful descending curve to the narrowly rounded posterior basal extremity. Cardinal area very narrow, with not more than two or three linear cartilage furrows. Surface marked with fine obscure concentric striæ, and a few not very apparent stronger marks of growth. Length, 1.08 inch—measuring obliquely from the umbonal extremity to the posterior basal margin; breadth at right angles to the longer axis, 0.51 inch; convexity of the two valves, 0.37 inch.

This species differs from *M. recta*, Shumard,* and *M. perattenuata*, Meek and Hayden,† in having its beaks not quite terminal, and its anterior margin above the middle, projecting in front of the beaks and umbonal ridge as a kind of lobe.‡ Its beaks are also much less attenuate and pointed. It also differs from *M. recta* in not having its umbonal ridge "angulated" nor its interior margins inflected at an acute angle with the plane of the body of the shell, while none of the specimens show any traces of the fine radiating striæ sometimes seen on that species. From *Myalina squamosa* (=*Mytilus squamosus*, Sowerby), some varieties of which (supposing that shell to vary to the extent represented by Prof. King) it resembles, it will be readily distinguished by its much narrower cardinal area. It is also a much less variable species.

Locality and position: Same as last.

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* St. Louis Academy of Sciences, i, p. 212. † Trans. Albany Inst., iv, March, 1858.

‡ This lobe is partly hidden by the matrix, in the specimen figured by Prof. McChesney.

MYALINA MELINIFORMIS, M. and W.

Pl. 27, fig. 3.

Myalina meliniformis, MEEK and WORTHEN, March, 1866. Proceed. Chicago Academy Sci., vol. i, p. 19.

SHELL rather small, mytiloid, very nearly equivalve, not very oblique; posterior margin rounding down with a broad regular curve from the extremity of the hinge; base rather regularly rounded; anterior margin descending at rather less than a right angle with the hinge, with a concave outline, in both valves inflected so as to meet at a very obtuse angle; hinge rather short, arched, and ranging at an angle of about 60 ° with the longer axis of the valves; beaks terminal and directed forward, not projecting above the hinge; umbonal slopes rounded, and curving down from the beaks near the anterior side—scarcely as convex as the sides of the valves just behind them. Cardinal area narrow and finely striated. Muscular impressions distinct, subcircular, and placed a little below and behind the middle of the valves; pallial scar well defined, and extending from the lower anterior side of each adductor impression a little forward, and then curving and ascending near the anterior side of each valve, as a row of dots, towards the beaks—posteriorly it ascends from the upper posterior side of the adductor scar, in the same way. Surface unknown. Length, from the beaks obliquely to the posterior basal margin, 1.05 inch; breadth (antero-posterior diameter), 0.52 inch; convexity, 0.35 inch.

We only know this species from internal casts, from which, however, it is seen to differ materially from the last, in being very much less oblique, and in having no lobe-like projection, in front of the beaks. It is much more nearly allied to *M. permiana* of Swallow, from which it differs in having its umbonal slopes much less prominent, and more rounded, while the sides of its valves, just behind and above these umbonal slopes, are more convex. In form it is almost an exact miniature of a large ponderous shell figured on page 33 of

Meek and Hayden's *Palæont. Upper Missouri*, as *M. subquadrata*, of Shumard. In addition to its greatly smaller size, however, it differs in having its valves more convex in the postero-dorsal region, and its hinge more arched.

Locality and position: Same as last.

MYALINA RECURVIROSTRIS, M. and W.

Pl. 26, figs. 9*a*, 9*b*, 9*c*.

Myalina recurvirostris, MEEK and WORTHEN, October, 1860. Proceed. Acad. Nat. Sci., Philad., p. 456.

SHELL of medium size, moderately thick, obliquely subtrigonal, distinctly inequivalve (the left valve being more convex and thicker than the other); very gibbous and narrowly rounded along the umbonal slopes. Hinge nearly or quite straight, about equaling in length the height of the shell in young specimens, but proportionally shorter in adult examples. Posterior side compressed; its margin a little convex in outline, ranging nearly at right angles to the hinge above, and rounding gradually into the narrowly rounded base below; anterior side a little concave in outline, and ranging at an angle of about 55 ° with the hinge. Beaks small, teminal, pointed, that of the left valve being twisted so as to make nearly one entire turn at the extreme point, which is directed obliquely forward; beak of right valve less prominent, nearly straight, and directed forward. Surface of left valve marked by distinct lines, and imbricating laminæ of growth, which are quite prominent on the anterior side and near the cardinal margin behind; right valve more obscurely marked. Ligament area comparatively narrow, and marked by a few distinct longitudinal furrows. Anterior margin immediately under the beaks thickened, so as to present a broader area than the hinge, from which it is separated, in the left valve, by an oblique groove, and in the other by a corresponding prominence. Posterior muscular impression large, elongated or narrow-subovate, pointed above and rounded below, located near the middle of the posterior side, and curved parallel to the margin of the valves. Height, measuring at right angles to the hinge, 1.73 inches; breadth, at right angles to height, about 1.66 inches; convexity, 0.95 inch; greatest length, parallel to the umbonal ridges, 2.12 inches.

In size and general outline this shell resembles somewhat a species described from Kansas, by Dr. Hayden and one of the writers, under the name of *Myalina aviculoides*, (*Proceed. Acad. Nat. Sci., Philad.*, May, 1860, p. 184*). It differs, however, materially in the spirally curved character of the beak of its left valve, and the less sinuate outline of its anterior side. It also differs in having much stronger imbricating marks of growth, particularly on the left valve. The Kansas species is likewise more nearly equivalve, and has its anterior side more prominent, or somewhat lobed just under the beaks.

NOTE.—Since the above was written, farther comparisons lead us to suspect that this species is identical with *M. kansasensis*, Shumard, (*Trans. St. Louis Academy Sci.*, i, p. 213), though none of our specimens show any traces of the crenate lamallæ mentioned in the description of that species.

Locality and position: La Salle, Illinois; about the horizon of No. 11 Coal, of Upper Coal Measures.

GENUS SCHIZODUS, King, 1844.

(Ann. Mag. Nat. Hist., xiv, p. 313.)

SCHIZODUS —— (sp?).

Pl. 27, fig. 7.

We only know this shell from imperfect casts, that give a rather unsatisfactory idea of its specific characters. Since our figure was engraved, however, we have found a better specimen, by breaking some masses of the matrix, than that from which our drawing was made. From this it would seem that the one represented by our drawing has lost portions of its anterior ventral margin, and that our outline restoration of the broken posterior margin is not exactly correct. Hence it is probable that our figure is turned so as to represent the beaks and umbonal slopes as being too oblique, and the former too near the anterior extremity. Since seeing the better specimen alluded to above, we are much inclined to believe this to be the species figured and described by Prof. Hall, under the name *Dolabra? alpina*, in the Iowa Report (p. 716, pl. 29, fig. 2). It is clearly not a *Dolabra*, however, but a true *Schizodus*, as was (in regard to the Iowa specimen) first pointed out by Meek and Hayden, in a note on page 58 *Palæontology of the Upper Missouri*.

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* See also Palæontology of Upper Missouri, part 1, pl. ii, fig. 8*a*, 8*b*, 8*c*, 8*d*.

Both of the casts before us show a rather distinct sulcus, passing obliquely backwards and downwards from the posterior side of each beak along the umbonal slopes. This sulcus was of course occupied by a corresponding ridge on the inside of each valve. Somewhat similar marks are represented on casts of *Schizodus obscurus*, figured by Geinitz (Dyas, pl. xiii), though our fossil is very unlike that shell in other respects, and apparently more nearly allied to *S. truncatus* of King, but still distinct from that also.

Locality and position: North Branch of Saline creek, Gallatin county, Illinois; Upper Coal Measures.

GENUS EDMONDIA, de Koninck, 1844.

(Anim. Foss. Carb. Belg., 66.)

EDMONDIA UNIONIFORMIS, (sp.) Phillips?

Pl. 27, fig. 6, 6*a*, and 6*b*.

Isocardia unioniformis, PHILLIPS, 1836. Geol. Yorks., ii, p. 209, pl. 5, fig. 18.
Edmondia unioniformis, DE KONINCK, 1844. Anim. Foss. Belg., p. 67, pl. 1, figs. 4*a*, 4*b*, 4*c*.

SHELL gibbous, oval-suborbicular, the length being a little greater than the height; greatest convexity near the middle of the valves; basal margin forming a semi-elliptic or semi-oval curve; anterior margin rather more narrowly rounded than the posterior, which latter is sometimes faintly truncated; cardinal margin rather short, straight, and horizontal behind the beaks. Beaks gibbous, rather prominent, incurved, and placed a little nearer the anterior than the posterior side. Surface marked with small, irregular, concentric ridges and fine striæ, which are apparently sometimes crossed by very obscure traces of radiating lines on the posterior dorsal region. Length, 1.06 inch; height, 0.90 inch; convexity, 0.70 inch.

It is with considerable hesitation that we refer this species, even with a query, to Phillips's *unioniformis*. It certainly looks so unlike his figure that we should scarcely have thought even a comparison necessary, had it not been that Prof. de Koninck very positively identifies with Phillips's species, after a direct comparison with authentic English specimens, a form differing but slightly from our shell. Prof. de Koninck's figures represent a form rather more gibbous, and more rounded in outline behind, than that figured by us, but some of our specimens, not figured, agree more nearly with his in these characters. Unless the *E. unioniformis* is a very variable shell, we should think it entirely distinct from ours, as well as from that figured by Prof. de Koninck.

Dr. Geinitz refers a shell to *Panopæa*, from the Permian rocks of Germany, somewhat like ours, but agreeing much more nearly with Prof. de Koninck's figures. (See *P. lunulata*, *G.—Dyas*, p. 58, pl. xii, fig. 22.) We cannot believe, however, that such a form can be properly referred to *Panopæa*, nor can we agree with those who refer to that genus *any* palæozoic species.

Prof. Swallow has described, in the *Transactions of the St. Louis Academy of Sciences*, several species from Kansas, under the names *Edmondia* and *Cardiomorpha?*, some one of which may be identical with our shell, but as he has only published rather brief descriptions, without figures, we have not the means of satisfactorily determining this point.

Our figure is from an internal cast, and shows the impression (fig. 6 and 6 *a*) of the internal cartilage plate.

Locality and position: North branch of Saline creek, Gallatin county, Illinois; Upper Coal Measures.

GENUS PLEUROPHORUS, King, 1844.

(Ann. Mag. Nat. Hist., xiv, p. 313.)

PLEUROPHORUS SUBCOSTATUS, M. and W.

Pl. 27, fig. 2 and 2 *a*.

Pleurophorus subcostatus, MEEK and WORTHEN, Dec., 1865. Proceed. Acad. Nat. Sci., Philad., p. 246.

SHELL elongate-oblong, moderately convex; umbonal ridges the most convex part of the valves, and extending obliquely from the beaks towards the postero-basal margin; anterior ventral region somewhat compressed; basal and cardinal margins very nearly straight and subparallel, the former being usually somewhat sinuous or arcuate along the middle; extremities rather narrowly rounded, the posterior being generally a little wider than the other, and sometimes faintly subtruncate obliquely. Hinge line long and nearly straight; posterior lateral tooth of each valve elongated parallel to the hinge margin, very remote from the cardinal teeth, and extending back a little beyond the posterior muscular impression. Beaks depressed upon a line with the dorsal margin, small, somewhat compressed, and placed about one-ninth the entire length of the shell behind the anterior margin. Scar of the anterior adductor muscle deep, trigonal-subovate, pointed above, and strongly defined by the prominent vertical ridge just behind it; those of the pedal muscles small, nearly marginal, and located directly over the anterior adductors; posterior adductor scars larger and more shallow than the anterior, subquadrate in outline, and placed close up under the posterior hinge teeth. Pallial impression well defined. Surface of casts showing traces of a few obscure concentric markings, crossed on the posterodorsal region by traces of about three equal obscure radiating costæ. Exterior surface and cardinal teeth unknown. Length of a medium sized specimen (internal cast), 0.88 inch; height of do., 0.37 inch; convexity, 0.26 inch. Some larger specimens, of same proportions, measure 1.33 inches in length.

This species is apparently related to *P. costatus*, of Brown (sp.), some varieties of which, as figured by Prof. King (*Monogr. Permian Fossils, England*, pl. xv), it closely resembles, at any rate so far as can be determined from the comparison of internal casts. Yet it evidently differs from that species, in having the scars of its pedal muscles nearly marginal, and placed *directly over* those of the anterior adductors, instead of partly behind them upon the internal ridge. This ridge is also stronger in our species, while the basal margins of its valves are likewise more sinuous.

This shell is also scarcely distinguishable from a form that has been regarded as a variety of *P. subcuneatus*, Meek and Hayden, in the Permian and Permocarboniferous beds of Kansas. Whether specifically identical with this Kansas shell (the supposed variety of *P. subcuneatus*), may admit of some doubt; but it certainly differs materially from the typical form of *P. subcuneatus*, not only in attaining a much larger size, but in its distinctly sinuous instead of convex basal margin; also in the presence of radiating postero-dorsal costæ.

Locality and position: North branch Saline Creek, Gallatin county, Illinois, in a bed belonging to the Upper Coal Measures.

GENUS SOLENOMYA, Lamarck, 1819.

(Solemya, Lamarck, An. Sans. Vert., vol. v.)

SOLENOMYA RADIATA, M. and W.

Pl. 26, fig. 10 *a*, 10 *b*.

Solemya radiata, MEEK and WORTHEN, October, 1860. Proceedings Acad. Nat. Sci., Philad., p. 457.

SHELL thin, narrow oblong-oval or elongate subelliptical, moderately convex, nearly closed at each end; pallial margin rather straight or very slightly contracted along the middle, and rounding up more gradually in front than behind; anterior (longer) side narrowly rounded, its most prominent part being above the middle; posterior (shorter) side narrowly rounded below and obliquely subtruncate above; dorsal outline nearly parallel to the base; beaks much depressed, located less than one-fourth the entire length of the shell in advance of the posterior extremity. Surface with obscure marks of growth, crossed by flat, nearly obsolete, radiating plications, which are sometimes separated, near the middle of the valves, by spaces greater than their own breadth; plications very oblique and more closely arranged on the anterior side. Length, 1.17 inches; height, 0.47 inch; convexity, about 0.33 inch.

Some specimens show the radiating plications nearly as distinctly on the internal cast as on the exterior of the shell. These casts retain distinct impressions of an oblique ridge just in advance of the posterior muscular impression, but both the muscular scars seem to be very faintly marked. It is possible our specimens may have been partly closed by pressure in the matrix, though they have the appearance of having been but slightly gaping at either end—more particularly behind.

From the same locality and position we have a few specimens of a nearly allied form, that may possibly belong to the same species as this, though we think they are distinct. These are considerably larger and less depressed, with scarcely any traces of radiating markings, but have more distinct concentric wrinkles. They also differ in being more broadly rounded in front.

The species under consideration (*S. radiata*) seems to be related to *S. primæva* of Phillips (*Geol. Yorksh.*, vol. ii, tab. 5, fig. 6), but differs in being less depressed, more narrowly round in front, and entirely destitute of any traces of fine radiating striæ between the obscure costæ.

Locality and position: Schuyler county, Illinois; Coal Measures.

GENUS ALLORISMA, King, 1844.

(Ann. Mag. Nat. Hist., xiv, p. 315.)

ALLORISMA (sp. undt).

Pl. 27, fig. 9, 9 *a*.

THE only specimen of this species we have seen is a mere cast, not entirely perfect at either extremity, so that we have not the means of determining satisfactorily whether it is new or not. As near as can be determined, it seems to be proportionally shorter and more gibbous than any otherwise similar species with which we are acquainted. In a side view it is not unlike a species from the middle Coal Measures at Lexington, Missouri, described by Prof. Swallow, under the name *A. lata*. On comparison, however, with the typical specimen of that species, it was found to be much more gibbous, and marked with proportionally larger concentric ridges. Compared with *A. subcuneata*, Meek and Hayden, from the Coal Measures of Kansas (*Palæontology Upper Missouri*, pl. i, fig. 10 *a*, 10 *b*), it will be seen to be proportionally much shorter, and more broadly rounded posteriorly.

Locality and position: North Branch Saline creek, Gallatin county, Illinois; Upper Coal Measures.

GASTEROPODA.

GENUS PLEUROTOMARIA, Defrance, 1826.

(Dict. Sci. Nat., xli, p. 381.)

PLEUROTOMARIA SUBCONSTRICTA, M. and W.

Pl. 28, figs. 6 *a*, 6 *b*, 6 *c*.

Pleurotomaria subconstricta, MEEK and WORTHEN, Oct., 1860. Proceed. Acad. Nat. Sci., Philad., p. 458.

SHELL small, conical-subovate, longer than wide; spire moderately elevated. Volutions five and a half to six, obliquely flattened or concave above, excepting near the suture, where there is a subangular prominence occupied by a series of small folds or nodes. Body whorl forming rather more than half the entire length, biangular around the middle, the lower angle being less prominent and more obtuse than the other, and not exposed on the spire, while the other passes around near the middle of each upper turn; between the two angles, the middle of the body volution is vertically flattened, or a little concave, while its under side is convex. Suture linear, but occupying a rather distinct, somewhat rounded constriction or depression. Aperture broad, subovate, or subcircular. Columella rather arcuate, not perforated. Surface ornamented by about fifteen revolving lines, some ten or twelve of which occupy the under side of the body whorl, where they are larger than above; crossing all these lines, are extremely fine, closely arranged transverse striæ, which, on the under part of the body turn, show a tendency to cluster into small, regular wrinkles. Spiral band narrow, flat, and located just above the middle angle. Length, 0.33 inch; breadth, 0.24 inch; apical angle nearly regular; divergence, 65°.

As near as we have been able to determine from a brief written description, unaccompanied by figures, this species would seem to be related to *P. Prout-*

iana, Shumard (*Trans. Acad. Sci. of St. Louis*, vol. 1, p. 15), but as Dr. S. gives 43° as the divergence of the spiral angle of his species, while that of our shell measures about 65°, it is scarcely possible that they can be identical. Dr. S. also describes the revolving striæ as being finely granose on the under side of the body whorl in *P. Proutiana*, which is not the case with the species now before us—though they are sometimes apparently obscurely crenulated by the crossing of the small transverse wrinkles formed by the clustering of the striæ of growth.

Locality and position: Hodges creek, Macoupin county, Illinois; Lower Coal Measures.

PLEUROTOMARIA SPECIOSA, M. and W.

Pl. 28, figs. 5*a*, 5*b*, 5*c*.

Pleurotomaria speciosa, MEEK and WORTHEN, Oct., 1860. Proceed. Acad. Nat. Sci., Philad., p. 459.

SHELL attaining nearly a medium size; length slightly greater than the breadth; volutions seven to seven and a half, last one forming about half the entire length, all subangular just below the suture, thence obliquely flattened, or a little concave, to a distinct revolving carina, a little below the middle of the upper turns, and about the middle of the body whorl. Below this second much stronger angle, the outside of the last turn is vertically flattened, or somewhat concave, so as to produce a third more obtuse revolving prominence below the middle—beneath which the under side of the whorl is convex, but not ventricose. Suture well defined. Spiral band narrow, prominent, occupying and partly forming the middle revolving angle, neatly crenulated, like the milled edge of a piece of coin. Aperture subcircular, approaching a subquadrate outline; umbilicus small or nearly closed. Surface ornamented by eighteen to twenty-two thread-like revolving lines, about twelve of which occupy the under side of the body whorl, four to seven the upper slope, and two or three the outer flattened space around the middle. Crossing all these, there are numerous extremely fine, very regular, closely arranged, transverse lines, about every fourth or fifth one of which is considerably larger and more prominent than the others near the suture above; and they all curve obliquely backwards as they approach the angle supporting the spiral band. Length, 0.55 inch; breadth, 0.52 inch; apical angle regular, divergence 82 °; breadth of spiral band not more than about 0.03 inch.

This very neat, elegantly ornamented species, will be readily distinguished from any of those yet known in our Coal Measures (resembling it in form), by its peculiar prominent, neatly crenulated spiral band, and its extremely fine, closely arranged lines of growth.

Locality and position: Same as preceding.

PLEUROTOMARIA SCITULA, M. and W.

Pl. 28, figs. 9*a*, 9*b*, 9*c*, 9*d*.

Pleurotomaria scitula, MEEK and WORTHEN, Oct., 1860. Proceedings Acad. Nat. Sci., Philad., p. 461.

SHELL small, trochiform, length and breadth nearly equal; spire depressed-conical; volutions six, a little convex, last one prominent and narrowly rounded, or subangular on the periphery, slightly convex below; suture somewhat canaliculate; aperture subcircular, approaching a subquadrate form; umbilical region impressed, but not distinctly perforated; spiral band of moderate breadth, concave, and located a little above the periphery of the body whorl, but passing around, slightly below the middle of the other volutions. Surface ornamented by from about seventeen to twenty-two revolving lines, only three or four of which occupy that part of the body whorl above the band, where they are larger and more widely separated than below; distinct, but much smaller, regularly arranged, thread-like lines, mark the volutions transversely. Length and breadth each about 0.22 inch; apical angle convex, divergence, 79 °.

This handsome, symmetrical little shell has much the form and general appearance of a *Solarium*, excepting that it has no umbilicus, and possesses the peculiar spiral band characteristic of the genus *Pleurotomaria*. On the upper part of the whorls, the transverse striæ crossing the revolving lines are very regularly arranged, at intervals a little greater than their own breadth, but in crossing the spiral band they become more crowded, and curve gracefully backwards, parallel to the sinus of the lip. They are also rather closely and very regularly arranged on the under side of the body whorl.

Locality and position: Same as last.

PLEUROTOMARIA BRAZOENSIS, Shumard?

Pl. 28, figs. 1*a*, 1*b*, 1*c*, 1*d*.

Pleurotomaria brazoensis, SHUMARD, 1860. Trans. St. Louis Acad. Sciences, i, p. 624.

SHELL rather under medium size, trochiform, height and breadth nearly equal. Volutions five and a half to six, obliquely flattened or a little concave above; last one composing about half of the entire length, flattened or slightly convex below, and very prominent around the middle, where it is provided with two nearly equal carinæ, between which is located the band of the sinus. On the spire only the upper of these carinæ is seen above the suture. Just below the well defined suture the upper edge of the whorls is a little thickened so as to form a subangular prominence, which is provided with a series of small, obscure nodes. Aperture subquadrate or subrhombic; columella perforated. Surface ornamented by about twenty-five small, thread-like, revolving lines, some twelve or thirteen of which occupy the underside of the body whorl; crossing all these are numerous similar, equidistant, transverse striæ, the whole forming a regular cancellated style of ornamentation. Length, 0.43 inch; breadth, 0.41 inch; spiral angle nearly regular, divergence, 70 °.

Being in doubt whether or not this species is really identical with Dr. Shumard's *P. brazoensis*, we have preferred to describe our specimens instead of quoting his carefully written diagnosis. They seem to agree very closely with the characters given by him, unless by the "thirteen to fourteen rather strong filiform striæ" he mentions as ornamenting the whorls, he intends to convey the idea that this is the entire number of these lines seen on any one whorl, including those on the under side of the body volution; in which case we should scarcely entertain a doubt in regard to our shell being a distinct species, since it uniformly has about double that number of revolving striæ on the last whorl. Dr. S. also describes the two sets of striæ as "giving the surface a handsome, crenulated appearance." The word "crenulated" here is probably a misprint; at any rate it is not applicable to the species before us, the striæ of which are not crenulated, but form a neat, cancellated style of sculpturing having much the appearance, as seen under a magnifier, of a piece of musquito netting pasted upon a smooth surface.

Should the shell under consideration prove to be distinct from that described by Dr Shumard, which is not improbable, we would propose to designate it by the name of *Pleurotomaria intertexta*.

Locality and position: Hodge's creek, Macoupin county, Illinois; Lower Coal Measures.

PLEUROTOMARIA TENUICINCTA, M. and W.

Pl. 28, fig. 3 *a*, 3 *b*, 3 *c*, 3 *d*.

Pleurotomaria tenuicincta, MEEK and WORTHEN, October, 1860. Proceed. Acad. Nat. Sci., Philad., p. 459.

SHELL small, conical-ovate; spire moderately elevated; volutions seven, obliquely flattened or concave above, convex and more or less distinctly angular around the middle, last one prominently rounded below; suture distinct; spiral band very narrow, concave, located a little above the middle of the body whorl, and passing around rather below the middle of the others; aperture apparently subcircular; umbilical region indented, but apparently not distinctly perforated. Surface ornamented by about fifteen to twenty, rather distinct revolving lines, only two or three of which occupy the flattened or concave upper slope above the band, where they are less prominent than the others; while the two forming the margins of the band are more salient than any of those below. Fine, regularly arranged striæ, which are much more distinct near the suture on the upper slope than below the band, mark the whorls transversely. Length, 0.24 inch; breadth, 0.20 inch; apical angle a little convex, divergence 60°.

We have seen but a single specimen of this little shell, yet it differs sufficiently from all the other species we have met with from these rocks, to be readily distinguished. Amongst its most marked peculiarities, that may be mentioned, are the prominently rounded, or ventricose character of the under side of its body whorl, and the extreme narrowness of its spiral band, with its prominent marginal carinæ. We know of no species very closely allied to it from foreign localities.

Locality and position: Springfield, Illinois; Upper Coal Measures.

PLEUROTOMARIA GRANULO-STRIATA, M. and W.

Pl. 28, fig. 2 *a*, 2 *b*, 2 *c*, 2 *d*.

Pleurotomaria granulo-striata, MEEK and WORTHEN, October, 1860. Proceed. Acad. Nat. Sci., Philad., p. 459.

SHELL very small, conical-subovate, or subtrochiform; spire moderately elevated; volutions compressed-convex, last one prominently rounded or subangular around the middle; suture well defined; aperture apparently subcircular; spiral band not distinctly defined, located near the middle of the body whorl, and passing around just above the suture on the other turns; calumella imperforate; surface ornamented by about twelve or thirteen comparatively distinct revolving lines, eight of which occupy that portion of the body whorl below the band, where they are a little smaller and more closely arranged than above.

On the upper sloping side of the whorls, the three or four revolving lines occupying that part of the shell are crossed obliquely by transverse lines, which are so much stronger on the revolving striæ than between them, that they present the appearance of small nodes or granules at the points of crossing.

A revolving line occupying the middle of the spiral band, is more prominent than the others, and obscurely crenulated. Length, 0.17 inch; breadth, 0.15; apical angle regular, divergence 60°.

The interrupted or granulose appearance of the striæ on the upper sloping side of the whorls in this little shell, will readily distinguish it from any otherwise similar species with which we are acquainted, in our rocks. In form and general appearance it resembles some of the species described by Prof. de Koninck and others in foreign works, but it differs in the details of its surface ornaments.

Locality and position: Macoupin county, Illinois; Lower Coal Measures.

PLEUROTOMARIA PRATTENI, M. and W.

Pl. 28, fig. 7*a*, 7*b*, 7*c*, 7*d*.

Pleurotomaria Pratteni, MEEK and WORTHEN, October, 1860. Proceed. Acad. Nat. Sci., Philad., p. 459.

SHELL very small, conical-ovate, the breadth being about two-thirds the length; spire rather elevated, but not acute at the apex; volutions six to six and a-half, slightly convex, increasing gradually in size, those of the spire more or less distinctly angular around the middle, last one sometimes slightly flattened around the most prominent part of the middle, just below the indistinct angle, and convex on the under side; suture well defined; spiral band of moderate breadth, flat, or sometimes slightly concave, occupying the middle of the body whorl, and passing around so as to bring its lower margin a little above the suture on the other turns. Aperture subcircular; columella imperforate; outer lip thin, sinus deep and comparatively narrow. Surface ornamented by about eighteen to twenty very fine revolving striæ, some twelve or thirteen of which occupy the body whorl below the band, where they are a little larger than those above the angle, and more regularly arranged; lines of growth extremely minute and obscure.

Length, 0.24 inch; breadth, 0.18 inch; apical angle convex, divergence, 37°.

The most marked peculiarity of this species is the fineness of its surface markings, particularly the lines of growth, which are scarcely visible even by the aid of a common lens. The revolving striæ, although much larger than those crossing them, are not distinctly seen without the use of a magnifier. Generally the carina on the middle of the upper whorls is well defined, but it becomes less distinct on the body volution. The measurements given above are from an adult specimen slightly above the medium size.

The specific name of this beautiful little shell was given in honor of our lamented friend, Henry Pratten, Esq., deceased, formerly of the Illinois Geological Survey.

Locality and position: Same as last.

PLEUROTOMARIA SUBSINUATA, M. and W.

Pl. 28, figs. *4a*, *4b*, *4c*, *4d*.

Pleurotomaria subsinuata, MEEK and WORTHEN, Oct., 1860. Proceed. Acad. Nat. Sci., Philad., p. 460.

SHELL under medium size, conical-ovate; spire rather elevated; volutions six, convex, last one in mature shells sometimes obliquely flattened a little above, just below the suture, thence rounded below; suture well defined; spiral band narrow, prominent, angular, located above the middle of the body whorl, at the lower edge of the slight flattening of its upper side, and passing around the middle of the upper turns; sinus of the lip shallow, judging from the slight curve of the lines of growth; aperture nearly circular; columella not distinctly perforated. Surface ornamented by about fifteen distinct revolving lines, some three or four of which on the middle are larger than those above, while those below gradually diminish in size towards the small umbilical impression; only two or three of the smaller lines usually occupy the slightly depressed portion of the whorls above the spiral band, where they are crossed obliquely by a series of regularly arranged wrinkles; lines of growth extremely fine and very obscure. Length of largest specimen, 0.40 inch; breadth, 0.31 inch; apical angle convex, divergence, 55°.

The spiral band of this species is so little apparent that we were at first in doubt whether it really belongs to the genus *Pleurotomaria*. On examining carefully, however, by the aid of a lens, the obscure lines of growth, we observe that they make a small but distinct backward curve in crossing the upper of the three or four larger revolving lines passing around the middle of the body whorl, so as to indicate the presence of a shallow sinus in the lip at the termination of this revolving line. The band of the sinus being angular or carinated, and scarcely larger than the other revolving lines, would not be distinguished from them, where the surface has been a little weathered so as to obliterate the obscure striæ of growth.

The surface markings will at once distinguish this shell from any of its associates, and we know of no foreign forms with which it is liable to be confounded.

Locality and position: Same as preceding.

PLEUROTOMARIA TURBINIFORMIS, M. and W.

Pl. 28, fig. 8 *a*, 8 *b*, 8 *c*.

Pleurotomaria turbiniformis, MEEK and WORTHEN, Oct., 1860. Proceed. Acad. Nat. Sci., Philad., p. 461.

Pleurotomaria bicarinata, MCCHESNEY, Feb., 1860. New Palæozoic Fossils, p. 90; (not *P. bicarinata*, Sowerby, sp., 1818, de Koninck, 1843, nor of Munster, 1844).

SHELL rather large, trochiform; height and breadth nearly equal; spire conical, moderately depressed; volutions about five and a half, flat, last one distinctly angular around the periphery, and flattened or slightly convex below; umbilical region a little concave; umbilicus very small, and bound by a small, obscure, revolving ridge; spiral band extremely narrow, grooved, occupying the angle around periphery of the body whorl, and passing around scarcely above the suture on the other volutions, margined above and below by a sharply elevated line; suture linear, having a somewhat banded appearance in consequence of the development of a rather distinct revolving line at the upper margin of each whorl; aperture apparently rhombic-subquadrate in form. Surface ornamented by about twenty obscure, closely arranged, revolving striæ, crossed by stronger, very regular transverse lines, which are most distinct on the upper part of the whorls, and pass with a gentle curve backward and outward to the spiral band. Below the angle the under side of the body whorl is nearly smooth, or only marked by very obscure lines of growth, and faint traces of revolving striæ. Length, about 0.93 inch; breadth, nearly 0.97 inch; apical angle regular, divergence 64°.

This shell seems to be very closely allied to *P. Riddelii*, of Shumard (*Trans. Acad. Sci. St. Louis*, vol. i, p. 625), and a more careful comparison with his description leads us to suspect that it may possibly prove identical. Yet, as Dr. S. describes his species as having only twelve or thirteen revolving lines on each whorl, while our shell shows uniformly nearly double this number, we are in doubt whether they should be considered identical or not. It is also related to *Pleurotomaria missouriensis*=(*Trochus missouriensis*, Swallow), but never attains near so large a size as that noble species, from which it also differs in having much stronger transverse striæ; while Prof. Swallow's species has not the prominent linear ridge just above and below the spiral band, seen in our shell.

At the time we first published our description of this species, we had not seen Prof. McChesney's paper in which he published it under the name *P. bicarinata*, nor had we any knowledge of its publication until about the 10th of March, 1860. Our paper was published Nov. 24th, of the same year. These dates are of no consequence, however, so far as the species under consideration is concerned, since the name under which Prof. McChesney published it, had been previously used for three other species, the first as far back as 1818.

Locality and position: Lasalle, Illinois; Upper Coal Measures.

PLEUROTOMARIA SUBSCALARIS, M. and W.

Pl. 28, figs. 10*a*, 10*b* (by error on the plate, 9*a*, 9*b*).

Pleurotomaria subscalaris, MEEK and WORTHEN, October, 1860. Proceed. Acad. Nat. Sci., Philad., p. 460.

SHELL large, rather thick, conical-ovate; spire moderately elevated; volutions six, those near the summit of the spire flattened, the others convex, and provided with a distinct, rather sharp, apparently smooth carina, which occupies a position a little above the middle of the body whorl, passes around near the middle of the second, becomes lower on the third, and sinks below the suture on the others. Below this angle there is on the body volution a second less distinct subangular prominence, with a broad, vertical, nearly flattened or slightly concave space between the two. Under side of last turn a little convex; umbilical region somewhat indented, but not perforated; suture well defined. Spiral band narrow, and occupying the principal angle of the whorls. Length, 2 inches; breadth, 1.83 inches; apical angle convex, divergence, 70°.

Our specimen is somewhat eroded, but it retains traces of about twenty rather strong revolving lines, eight or nine of which occupy the upper side of the whorls, above the carina, some three or four the flattened outer side of the body whorl, and the remainder the under side. On the upper sloping surface of the whorls there are also regularly arranged, oblique transverse striæ, which, in well-preserved specimens, are probably continued upon the outer and under sides of the last turn.

This fine species might be confounded, on a hasty examination, with *P. tabulata* of Conrad, with which it agrees in size and some other respects. It differs, however, in having the upper part of the spire much more depressed, and without any angle visible above the suture. The principal angle on its other turns appears to differ in being less prominent, and destitute of the crenulations so distinctly seen on that of *P. tabulata*. In addition to these differences, the substance of the shell under consideration is much thicker than in that described by Mr. Conrad.

Locality and position: Hodge's creek, Macoupin county, Illinois; Lower Coal Measures.

PLEUROTOMARIA? TUMIDA, M. and W.

Pl. 31, fig. 1*a*, 1*b*.

Platyostoma? tumida, MEEK and WORTHEN, October, 1860. Proceed. Acad. Nat. Sci., Philad., p. 463.

SHELL rather large, very thin, rhombic subovate in outline, a little longer than wide; spire much depressed or nearly flat;

volutions four to four and a-half, convex, increasing very rapidly in size; last one large, forming about eight-ninths of the entire length, prominent, and narrowly rounded above the middle, slightly convex on top, and contracted and somewhat extended below; suture well defined; aperture large, longer than wide, obovate, the inner side being straighter than the other; lip very thin; columella perforated?; surface (of an exfoliated specimen) retaining traces of rather strong revolving lines. Length, 1.24 inches; breadth, 1.20 inches; length of aperture, 1.05 inches; breadth, about 0.65 inch; apical angle regular, divergence, 1.32°.

We are in much doubt in regard to the generic relations of this shell, not having seen specimens in a condition to enable us to determine whether or not it possessed the spiral band and sinus in the lip, so characteristic of the genus *Pleurotomaria*. It certainly differs materially from the usual forms of the species of that genus, having more the outline of the recent genus *Ianthina*. We suspect it will prove to belong to an undescribed genus, which should probably include a Russian form figured by Murchison de Verneiul and Keyserling, in the *Geology of Russia*, pl. xxiii, fig. 14, as an undetermined *Ianthina*. If so, we would propose for the group the name *Ianthinopsis*, from its resemblance to the genus *Ianthina*.

We cannot believe that Carboniferous shells such as this can be properly referred to the recent genus *Ianthina*, since no species of that genus are known from any of the succeeding rocks, until we ascend to the most recent Tertiary beds; nor can we agree with d'Orbigny in placing them in the Lower Silurian genus *Scalites*, which was founded upon thick shell, with distinctly angular whorls.

Locality and position: Grayville, Illinois; Upper Coal Measures.

GENUS STRAPAROLLUS, Montfort, 1810. (See page 158.)

(Conch. Syst., ii, p. 174.)

STRAPAROLLUS UMBILICATUS, M. and W.

Pl. 29, figs. 1*a*, 1*b*, 1*c*.

Straparollus umbilicatus, MEEK and WORTHEN, Oct., 1860. Proceed. Acad. Nat. Sci., Philad., p. 462.

SHELL of medium size, depressed subtrochiform; spire rather elevated for a species of this genus; volutions five to five and a half, convex, increasing gradually in size, nearly horizontally flattened on the upper side, about half way across from the suture, where there is a rather distinct revolving angle; below this angle the upper oblique outer slope is slightly flattened to near the middle of the outer side, which, in the last whorl, is rather narrowly rounded; under side of last turn rounded to a moderately distinct angle within the middle, thence rounding into the umbilicus; umbilicus large, or nearly twice as wide as the diameter of the last whorl near the aperture, very deep, and permitting the inner side of all the volutions to be seen to the summit of the spire. Surface marked by fine, rather obscure or moderately defined lines of growth. Height, 0.88 inch; breadth, 1.15 inches; breadth of umbilicus, measuring across from its marginal angle on opposite sides, 0.68 inch; apical angle convex, divergence about 100 °.

This species is evidently closely allied to *Straparollus acutus*=(*Cirrus acutus*, *Sowerby*, *Min. Conch.*, pl. 141, figs. 1 and 2), but has a proportionally wider umbilicus and narrower whorls, while the angle on the under side of its last whorl is farther in, so as to form the margin of the umbilicus. Its lines of growth are also less strongly marked, those of *S. acutus*, being described by de Koninck as forming even imbricating laminæ on the last turn.

Locality and position: St. Clair county, Ill.; Lower Coal Measures.

Genus NATICOPSIS, McCoy, 1844.

(Carb. Foss. Ireland, p. 33.)

Synon.—*Natica*, of some authors; (not of Aadanson).

Shell oval or subglobose, solid, imperforate, composed of few, convex, rapidly expanding whorls, the last one of which is large; spire short; aperture broadly subovate, straighter on the inner side, and rounded below; columella callous, more or less distinctly flattened, and often showing a longitudinal impression for the reception of the edge of the operculum; sometimes transversely furrowed or striated; lip sharp and entire. Surface generally nearly smooth on the middle and

lower part of the whorls, and marked with more or less strongly defined, regular, oblique striæ or costæ near the suture above, rarely passing down upon the middle and lower part of the body whorl; sometimes covered with small nodes or granules.

This genus, as we understand it, includes at least three rather marked sections, which may be defined as follows:

1. **NATICOPSIS,** (proper.)

Shell smoother, excepting oblique striæ parallel to the lines of growth, near the suture.

N. Phillipsi, McCoy,* *N. ventrica*, Norwood and Pratten, *Natica plicistria*, Phillips, etc.

2. ————

Shell with oblique, strong striæ or costæ, most distinct near the suture, but well defined over the whole body whorl.

Nerita subcostata, Goldf.; *Littorina biserialis*, Phillips, etc.

3. **TRACHYDOMIA,** Meek and Worthen. (*τραχυς*, rough; *δωμα*, a house.)

Shell with surface ornamented with small, more or less regularly disposed, nodes or granules.

Naticopsis nodosa, Meek and Worthen; † *N.* (*Trachyd.*) *Wheeleri*=(*Littorina Wheeler*, Swallow); *Natica Mariæ*, Murchison, de Vern. and Keys.; *Buccinum breve*, Sowerby, etc.

In redefining this genus at a later date, in his valuable work on the *British Palæozoic Fossils*, p. 301, Prof. McCoy describes it as having "a minute umbilicus, only seen in the cast." As we have had an opportunity to examine numerous fine specimens of several species of this genus, without seeing any traces of a perforation in the columella, we can but regard the minute umbilicus mentioned by Prof. McCoy in the cast, as merely the cavity left in it by the columella itself.

The shells of this genus often have so much the aspect of some types of the *Neritidæ*, that we were at one time under the impression that they must belong to that family. On breaking open a number of specimens, however, of various species, and finding that the inner whorls are not absorbed away as in the *Neritidæ*, we were led to doubt the correctness of that conclusion, and since seeing numerous specimens of opercula found associated with these shells in our Coal Measures, under circumstances scarcely admitting of a doubt that they belong to them, we have been confirmed in the opinion that this genus must belong to some other family. The opercula alluded to, have exactly the form and size corresponding to the aperture of typical species of *Naticopsis*, with which they are associated, while they do not so agree with that of any other univalves known in the same rocks. · They are moderately thick and shelly, oval or subcircular in form, with a lateral or submarginal nucleus, and show *not the slightest traces of the spiral or subspiral stricture, and articulating projection*, so characteristic of the *Neritidæ*. On the inner side they show a distinct reniform scar of attachment, and on the outside the fine, but distinctly *concentric*, lines of growth. It will also be remembered that Prof. McCoy figured a specimen of *Naticopsis Phillipsi*, in his "*Carboniferous Fossils of Ireland*," with an operculum within its aperture, and that it shows no indications of a spiral structure.

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* This being the first species mentioned by McCoy, and agreeing best with his diagnosis, may be regarded as the type of the genus.

† We regard this as the type of this subgenus.

From all that is therefore known in regard to this genus, we are also inclined to doubt the propriety of referring it either to the *Naticidæ or Littorinidæ*, and to believe it will be found to be the type of an extinct family *Naticopsidæ*, near the *Naticidæ*.

We are not sure this genus occurs in the Silurian rocks; a few Devonian species seem to belong to it, but it attained its maximum development during the deposition of the Carboniferous deposits. It is also apparently represented by a few species in the *Permian* rocks.

NATICOPSIS NANA, M. and W.

Pl. 31, figs. 4*a*, 4*b*.

Platyostoma nana, MEEK and WORTHEN, October, 1860. Proceed. Acad. Nat. Sci., Philad., p. 463.

SHELL small, subglobose, wider than high, spire much depressed; volutions three, increasing very rapidly in size, last one large and ventricose; suture well defined; aperture large, broad-subovate, somewhat straightened on the inner side, equaling near seven-eighths the entire length of the shell; outer lip thin; inner lip not much thickened; columella slightly flattened. Surface marked by fine lines of growth, but slightly stronger and more regular near the suture on the upper side of the whorls. Length, 0.19 inch; breadth, 0.21 inch; length of aperture, 0.15 inch; breadth of ditto, 0.11 inch; apical angle about 123°.

Since describing this little shell, we have succeeded in clearing the matrix from the columella, which we find presents the characters of *Naticopsis*. It is a neat, symmetrical little species, somewhat resembling *Nerita spirata*, Sowerby, excepting that its spire is not so much depressed, while the upper side of its whorls are not flattened. It is proportionally shorter and more ventricose than *Naticopsis ventrica*=(*Natica ventrica*, Norwood and Pratten), from which it also differs in not having its body whorl constricted around the middle.

We have before us a number of specimens from the Lower Coal Measures on Hodge's creek, Macoupin county, Illinois, presenting almost precisely the same form and general appearance as the species under consideration, but differing in attaining three or four times as large a size, and in having the thickened columella sometimes transversely striated. It is possible the species here described may be identical with these, but we think the specimens alluded to from Hodge's creek, the young of a large ponderous species quite common at the same locality. If so it would seem scarcely possible that the little shell here described, from the Upper Coal Measures, can be the same species.

In our figure of the species under consideration, the engraver has, by some accident or mistake, carried a ridge around the inner upper side of the aperture, which gives it an unnaturally rounded appearance above.

Locality and position : Upper Coal Measures, Springfield, Illinois.

SUBGENUS TRACHYDOMIA, M. and W. (See page 364.)

NATICOPSIS NODOSA, M. and W.

Pl. 31, fig. 2*a*, 2*b*.

Naticopsis nodosa, MEEK and WORTHEN, October, 1860. Proceed. Acad. Nat. Sci., Philad., p. 463.

SHELL rather large, obliquely subrhomboidal in outline, rather thick; volutions four and a half, convex, increasing rapidly in size, last one large, gibbous, and composing three-fourths of the entire length, rounded on the outer side, and having a shallow revolving depression near the suture above; suture moderately distinct; aperture rounded subovate, somewhat straightened on the inner side; lip sharp; columella distinctly flattened, smooth, and having a small opercular groove near the base, not perforated. Surface ornamented by numerous prominent nodes, which are arranged in quincunx, so as to form oblique rows nearly parallel to the lines of growth, which are fine, rather regular, and scarcely deflected from their course by the presence of the nodes. Length, measuring from the most extended part of the aperture obliquely to the apex of the spire, 1.08 inches; breadth, 0.98 inch; apical angle convex, divergence about 100°.

Locality and position: St. Clair county, Illinois; Lower Coal Measures.

NATICOPSIS NODOSA *var.* HOLLIDAYI, M. and W.

Pl. 31, fig. 3 *a*, 3 *b*.

Naticopsis Holidayi, MEEK and WORTHEN, October, 1860. Proceed. Acad. Nat. Sci., Philad., p. 463.

THIS agrees so nearly with the last, that we doubt now, the propriety of regarding it as a distinct species. It only differs in having its columella more broadly flattened, and its nodes more numerous, and more crowded. In the figures of both of these forms, the engraver has made the nodes to appear to arise too abruptly from the surface of the shell. They are all more spreading at the base. Length, 1.24 inches; breadth, 1.10 inches; apical angle nearly regular, divergence 100°.

Locality and position: Hodge's creek, Macoupin county, Illinois; Lower Coal Measures.

GENUS MACROCHEILUS, Phillips.

Synon.—*Buccinum* (sp.), SOWERBY and others; (not of Linnæus).
Macrocheilus, PHILLIPS, 1841. Palæozoic Fossils, p. 103; (not Kirby, 1838, genus *Coleoptera*).
Plectostylus, CONRAD, 1842. Journal Acad. Nat. Sci., Philad., vol. viii, p. 275; (not Beck, 1837).

SHELL subglobose or more or less elongate; spire pointed at the apex, and composed of several smooth, moderately convex volutions; body whorl large; aperture ovate or subovate, rounded and sometimes slightly effuse below and angular behind; columella imperforate; outer lip thin, and without notch or sinus; inner lip thin or wanting above the middle of the aperture, more or less thickened, and generally twisted into an obtuse fold below.

As originally proposed by Phillips, this genus was made to include, in addition to the typical forms, species belonging apparently to our genus *Soleniscus*, and to *Naticopsis* of McCoy. If we were to follow the rule adopted by some, of always regarding the first species described by an author, under a new generic name, as the type of the genus, we would have to take *Buccinum breve*, of Sowerby, as the type of *Macrocheilus*, that being the first species described by Phillips. And as that shell seems to be a nodose species of McCoy's subsequently proposed genus *Naticopsis*, we would probably have to substitute the name *Macrocheilus* for the *Naticopsis* group. As Phillips, however, only referred the *B. breve* provisionally to his genus, and distinctly states that he thought it allied to *Natica*, and the species *B. arculatum* and *B. imbricatum* to his genus *Loxonema*, while he says he regards the other species as "alone sufficiently peculiar to deserve a generic title," it is evident he did not view any of those just mentioned as typical examples of his new genus. Consequently we must look for the type amongst the other included species, which are *Buccinum acutum*, Sowerby, and *Macrocheilus elongatus* and *M. harpula*, Phillips.* Hence de Koninck, and others who first followed Phillips in the use of this generic name, have regarded *M. acutus* and other congeneric species as typical forms; which conclusion has been adopted generally amongst Palæontologists. Consequently in proposing the clearly distinct genus *Soleniscus* (probably including *M. elongatus* of Phillips), we adopted the generally accepted opinion in regard to the particular group for which the name *Macrocheilus* should be retained, as had also been done by McCoy in proposing his genus *Naticopsis*.

As thus understood, Phillips's genus includes those rather thick, smooth, subglobose, oval, or more or less fusiform shells, with convex whorls, an oval aperture, neither distinctly notched nor provided with a canal below, and a more or less callous inner lip, usually twisted into an obtuse revolving fold on the imperforate, somewhat flattened columella, such as *M. acutus*, Sowerby (sp.), *M. primigenius*, Conrad (sp.) ;*M. maculatus*, de Koninck, *M. ventricosus*, Hall, *M. Newberyi*, Stevens, etc. These shells vary considerably in the elevation of the spire, though it is always acute at the immediate apex, even when depressed. In texture, smoothness of surface, the thickening and often obtusely folded character of their inner lip, as well as in general appearance, they remind one of those ponderous Cretaceous and Jurassic shells often referred to *Actæonella;* such for instance as *A. Reynauxiana*, d'Orbigny, *A. obtusa* and *A. elliptica*, Zekeli, upon which one of the writers has proposed to found a distinct genus,

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* He also included *M.? neglectus*, Phillips; but as he did so with a query, we could not view it as one of the intended typical species.

Trochactæon.* The Carboniferous species of *Macrocheilus* were doubtless originally handsomely colored shells, since a species described by de Koninck, from the Carboniferous rocks of Belgium (*M. maculatus*), retains rows of large rectangular, oblong spots, like some of the modern Mitras and Cones.

The elongated species of this genus are not always easily distinguished from certain forms of *Polyphemopsis*, especially when the aperture and columella cannot be seen. They, however, differ entirely in their thickened inner lip, usually provided with an obtuse fold, and in generally having the body whorl proportionally larger. They also differ in having a larger aperture, which is more rounded below. From *Loxonema*, with which they are sometimes confounded, they are distinguished by their more callous inner lip, with its fold or ridge, their usually less elongated spire, and smooth surface.†

So far as known to us, the genus *Macrocheilus* seems to have been introduced during the Devonian epoch, and attained its maximum development during the deposition of the Carboniferous rocks, particularly the Coal Measures. Prof. King refers to it an elongated shell from the Permian rocks of England (*M. symmetricus*), resembling some species, apparently of this genus, from the Coal Measures of the Western States, excepting that its columella seems not to be thickened, and its lines of growth have a flexure more like we see in *Loxonema*, to which genus it may more properly belong. We cannot remember any Triassic species, though it is not improbable that the genus was represented during that epoch.

Mr. A. Adams refers to this genus a recent shell from the coast of Japan, under the name *M. japonicus* (*Ann. and Mag. Nat. Hist.*, 1860, p. 407), and says it agrees almost exactly, in form, with *M. acutus*, but has no fold on the columella, which is thickened. Notwithstanding its close resemblance to the type of the genus *Macrocheilus*, we may reasonably doubt its identity with that genus, of which we have no authentic examples from the Jurassic, Cretaceous or Tertiary rocks.

It is not improbable that the rules of nomenclature may require that the name of this genus shall be changed, because it had been previously used for a genus of *Coleoptera*. Mr. Conrad's genus, *Streptostylus*, was evidently founded upon internal casts of one or two species of this genus; and his name might be retained for it, in case it should be thought desirable to make a change, were it not for the fact that it was proposed for another group of Mollusks by Beck, in 1837.

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* See *Am. Jour. Sci.*, xxxv, sec. series, p. 89, for a paper on the *Actæonidæ*, to which family the genus *Macrocheilus* seems to belong.

† By some error, Chenu figures *Pleurotomaria Yvanii*, Leveille, a spirally striated shell (Conch., i, p. 228), as *Macrocheilus acutus*, Sowerby.

MACROCHEILUS MEDIALIS, M. and W.

Pl. 31, fig. 5 *a*, 5 *b*.

Macrocheilus medialis, MEEK and WORTHEN, October, 1865. Proceed. Acad. Nat. Sci., Philad., p. 466.

SHELL of medium size, rather thick, rhombic-subovate; spire depressed conical, acutely pointed at the immediate apex, forming about one-third the entire length; whorls six to six and a half, convex, increasing rapidly in size, last one large, but not very ventricose, the widest part being near the middle; suture moderately distinct; aperture rather narrow subovate, or subrhombic, acutely angular above, and narrowly round or slightly effuse at the base of the columella below; outer lip sharp, nearly straight in outline; columella somewhat tortuous, and more or less sinuous about half way up the aperture; inner lip thickened to the top of the aperture, and showing a slight tendency to form an obtuse fold or prominence just below the sinuosity at the middle of the columella, marked by regular, obscure, transverse wrinkles or striæ above the middle. Surface apparently smooth, but showing under a lens obscure traces of fine lines of growth. Length, 1.17 inches; breadth, 0.83 inch; length of aperture, 0.72 inch; breadth of ditto, 0.37 inch; apical angle convex, divergence 83°.

On comparing what we believe to be authentic examples of *Macrocheiles primigenius*, Conrad (sp.), sent by Dr. R. P. Stevens, from the Coal Measures near Pittsburgh, Pennsylvania, with the form under consideration, we find that they differ from our shell in having the body whorl more ventricose, the revolving fold on the columella more distinct, and the broad spiral furrow above it deeper, and continued down around the base of the body whorl. These Pennsylvania specimens, also show no traces of the small transverse wrinkles, or striæ, seen on the callous of the inner lip of our species above the middle of the aperture.

The engraver did not follow carefully enough the shading of the drawing, in fig. 5*a*, of our plate 31, representing the aperture of this shell. This defect makes the columella look too flat and straight in the figure.

Locality and position: Upper Coal Measures; Springfield, Illinois.

MACROCHEILUS INTERCALARIS, M. and W.

Pl. 31, fig. 6 *a*, 6 *b*.

Macrocheilus intercalaris, MEEK and WORTHEN, October, 1860. Proceed. Acad. Nat. Sci. Philad., p. 467.

Macrocheilus pulchellus, MEEK and WORTHEN, Oct. 1860. Ib.

SHELL of medium size, rhombic-subovate; spire conical, forming about one-third the entire length, pointed at the extremity; volutions six to seven, compressed-convex, increasing rather rapidly in size, last one comparatively large, but not ventricose, widest near the middle, and compressed above; aperture narrow subovate, acutely angular above, narrowly rounded and slightly effuse below; outer lip sharp, a little prominent along the middle; columella somewhat tortuous, moderately callous, and provided with an oblique prominence or obtuse fold near the middle of the aperture, sinuous just above the fold. Surface smooth, but showing under a lens, obscure traces or lines of growth. Length, 1.15 inches; breadth, 0.70 inch; length of aperture, 0.70 inch; breadth of ditto, 0.34 inch; apical angle convex, divergence 64°.

This species differs from the last, not only in being less ventricose, and in having the whorls less convex, but in having the callosity of its inner lip smooth, instead of striated above the middle. The differences of form are generally more strongly marked than would appear from our figures 5 *a* and 5 *b*, since a majority of the specimens of *N. medialis* have the body whorl proportionally larger, and the spire shorter, than in the specimen represented by our figures 5 *a* and 5 *b*, though that is much the best specimen we have seen.

We now regard the form we described under the name *M. pulchellus*, as most probably only a variety of the *M. intercalaris*. It is exceedingly difficult, sometimes, to separate the species in this genus, since they are generally variable, and are sometimes very closely allied.

Amongst the specimens sent by Dr. Stevens from Pittsburgh, there are two that we think belong to this species, as they agree well with its type in form and general appearance, while they differ materially from those we regard as *M. primigenius*, from the same locality.

Locality and position: Same as last; also from same horizon at Pittsburgh, Pennsylvania.

MACROCHEILUS, (undt.)

Pl. 27, fig. 10.

OF this shell we have only seen internal casts, none of which show the aperture nor the columella; hence we cannot determine whether it is identical with any of the described species or not. In form it seems to agree quite nearly with *M. primigenius*, Conrad (sp.). The impression left by the columella, however, in the matrix, appears to show no traces of the obtuse fold seen on that of Mr. Conrad's species. It mày be a new species, but we have thought it would be better not to propose a new name for it until other specimens can be obtained for examination.

The appearance of an umbilicus in the figure is merely the cavity occupied by the columella, the specimen being an internal cast, and the appearance of fine, revolving striæ on the body whorl, is an error in the engraving.

Locality and position: Bridge north branch Saline river, Gallatin county, Illinois; Upper Coal Measures.

GENUS POLYPHEMOPSIS, Portlock.

Synon.—*Buccinum* (sp.), Sowerby, 1839. Murchisons Sil. Syst., p. 642; (not Linnæus, 1758).
Polyphemus (sp.), Sowerby, 18—. Geol. Trans. (2d ser.) vol. v, p. 492; (not Montfort, 1810.)
Polyphemopsis, Portlock, 1843. Geol. Londonderry, p. 415.
Bulimella, Hall, 1856. Trans. Albany Inst., vol. iv; (not Pfeiffer, 1852).

SHELL subfusiform, spire more or less elongated, and usually pointed at the apex; whorls flattened or somewhat convex, last one moderately large, but not ventricose, generally forming more than half the entire length, somewhat produced below; outer lip simple, thin and nearly straight; inner lip wanting (or sometimes a little developed below, and winding around up the columella, so as to pass out of sight opposite the middle of the aperture?); columella without folds or callosity, slightly twisted or winding, curved outwards below to meet the outer lip, at the connection with which it is usually truncated; aperture narrow subovate, in the typical species effuse, or slightly notched at the base of the columella; surface smooth, or only with obscure lines of growth.

The shells belonging to this group have generally been supposed to be related to *Achatina* and *Bulimus*. They have not, however, as remarked by Col. Portlock, the obtuse mammillated apex of *Achitina* (*Polyphemus*), to which they have been sometimes referred, while their smooth, or even polished surface—only showing obscure lines of growth under a magnifier—gives them a different aspect from any of the land shells with which they have been compared. In addition to this, the fact that all their associates, both in this country and in Europe, are clearly marine types, is a sufficient evidence that they are not related to any of these land shells. On the contrary, they seem rather to be related to the *Ulimidæ*, or some of the allied families.

The Silurian group *Subulites*, Conrad, 1847, presents, so far as known, apparently the essential characters of this genus, and if generically distinct, evidently belongs to the same family. The close similarity of these types is not so apparent in the particular species figured by us, as in *P. elongata*, of Portlock (*Geol. Lond.*, pl. 31, fig. 2), and *P. fusiformis*=(*Polyphemus fusiformis*, Sowerby; *Geol. Trans.*, vol. v, pl. xxix, fig. 26), both of which are typical Carboniferous species of this genus.

Where the aperture and columella cannot be seen, it is sometimes difficult to distinguish these shells from elongated forms of *Macrocheilus*, from which they differ in wanting the callosity and fold, or revolving ridge, of the columella, characterizing that type, and in the truncated base of the columella. The latter character, and their smooth surface—destitute of the distinct curved striæ or costæ,—distinguishes these shells from Phillips's *Loxonema*.

The little shells upon which Prof. Hall proposed to found a genus *Bulimella*, agree exactly in all their generic characters with *Polyphemopsis*. It is true they are much smaller than the types of that genus, such as *P. elongata* and *P. fusiformis*, but if we were to make size a generic character in this instance, we would have, on the same principle, to create new genera for nearly all the shells found at the same locality, since they are almost all diminutive in size, although presenting exactly the generic characters of *Murchisonia*, *Pleurotomaria*, *Loxonema*, *Conularia*, *Conocardium*, and various other genera. The species described by Prof. Hall under the preoccupied name *Bulimella*, are *Polyphemopsis bulimiformis*, *P. canaliculata* and *P. elongata*.

The presence of an inner lip below the middle of the columella, of some species of this genus, is stated with doubt in our diagnosis, because we have only seen it in one species (our *P. peracuta*), which may possibly not belong properly to this genus.

Unless this group includes *Subulites*, and some doubtful Devonian forms, it would seem to be confined to the Carboniferous rocks.

POLYPHEMOPSIS INORNATA, M. and W.

Pl. 31, figs. 8*a*, 8*b*, 8*c*.

Loxonema inornata, MEEK and WORTHEN, October, 1860. Proceed. Acad. Nat. Sci. Philad., p. 463.

SHELL small, conoid-subfusiform; spire moderately elevated, pointed but not attenuate at the apex; volutions seven, nearly flat, increasing rather gradually in size, last one somewhat prominently rounded in the middle, but not ventricose, forming about two-thirds the entire length; suture rather shallow; aperture narrow subovate, angular above and somewhat effuse below; columella arculate and tortuous; outer lip thin, not sigmoid in outline; surface smooth or only showing very obscure traces of fine striæ of growth under a good lens. Length, 0.38 inch; breadth, 0.18 inch; apical angle convex, divergence about 30°. Length of aperture, 0.16 inch; breadth of ditto, 0.09 inch.

This species resembles our *P. peracuta* somewhat, but is much smaller. It is also proportionally shorter, and has scarcely more than half the number of whorls; while its volutions are rather more convex, and its spire not near so slender, nor so pointed. It also wants the inner lip of that species. Our specimens have the lip broken at the base of the aperture, so as to make the figure 8*a*, appear as if the columella is more abruptly truncated, than is natural.

Locality and position: Springfield, Illinois; Upper Coal Measures.

POLYPHEMOPSIS NITIDULA, M. and W.

Pl. 31, fig. 9*a*, 9*b*.

Loxonema nitidula, MEEK and WORTHEN, October, 1860. Proceed. Acad. Nat. Sci., Philad., p. 465.

SHELL of medium size, subfusiform; spire elongated, conical, rather attenuate and acutely pointed above; volutions eight to eight and a half, rather convex, last one comparatively large, composing less than two-thirds of the entire length, somewhat contracted and produced below; suture well defined, especially between the lower whorls; aperture narrow-subovate, a little oblique, acutely angular above; rather narrow, and apparently provided with a small, rounded sinus at the base of the columella below; outer lip thin and sharp, with a slightly prominent margin; columella arcuate, and somewhat twisted below; inner lip nearly or quite obsolete above. Surface smooth, but showing under a magnifier extremely fine, obscure lines of growth. Length, 1.10 inches; breadth, 0.43 inch; apical angle regular, divergence 30°. Length of aperture, 0.47 inch; breadth, 0.20 inch.

This species has much the form and proportions of *Macrocheilus fusiformis*, Hall (*Iowa Report*, pl. 29, fig. 7), but seems to be more attenuate, and has a rather more rapidly ascending spire. The figures given by Prof. Hall, however, are from an imperfect specimen, and it is possible that when we can have an opportunity to compare the aperture, it may be found necessary to include these forms under one name, as more varieties of the same species. If so, that proposed by Prof. Hall cannot be retained, for the reason that the name *fusiformis* had been used, by Sowerby, for one of the typical species of this genus.

The form under consideration may be distinguished from the last described species by its larger size, more slender and more pointed spire, deeper suture, and more convex whorls. We have not seen a specimen with the lip quite perfect below; the one figured, owing to a fracture of the lip, makes the truncation of the columella appear too distinct, though the lines of growth show that it must be rather distinctly truncated.

Locality and position: Same as preceding.

POLYPHEMOPSIS PERACUTA, M. and W.

Pl. 31, fig. 7*a*, 7*b*.

Eulima? *peracuta*, MEEK and WORTHEN, October, 1860. Proceedings Acad. Nat. Sci., Philad., p. 466.

SHELL rather large, elongate-conical; spire much elevated, attenuate, very acutely pointed at the apex. Whorls about thirteen, nearly or quite flat, and increasing gradually in size; last one forming more than half the entire length, slightly prominent around the middle, somewhat extended below; suture moderately distinct between the lower whorls, but scarcely impressed above. Aperture rather narrow-subovate, acutely angular above, narrow and apparently somewhat effuse below; outer lip thin, sharp, and nearly straight; inner lip somewhat reflexed below, and winding around the columella so as to pass out of sight opposite the middle of the aperture; obsolete above; columella arcuate and tortuous, curving outwards to connect with the outer lip at the base of the aperture. Surface smooth, but showing under a good lens extremely fine, very obscure striæ of growth. Length, 1.67 inches; breadth, 0.54 inch; apical angle regular, divergence 22°. Length of aperture, 0.55 inch; breadth of ditto, 0.30 inch.

We have seen this beautiful species in collections labeled *Loxonema Hallii*. A single glance, however, at the figure and description of that species published by Norwood and Pratten (*Jour. Acad. Nat. Sci., Philad.*, vol. iii, p. 77, pl. ix, fig. 11), will be sufficient to satisfy any one that it is a clearly distinct species. Norwood and Pratten represent their species as having the upper edge of the whorls tumid, and separated by a deep suture; while all the volutions in our shell are nearly or quite flat, with a very shallow suture between. It also has three or four more whorls and a totally different formed aperture—that of *L. Hallii* being "three times as long as broad," while in our species it is scarcely twice as long as wide. Our shell has likewise a much more arcuate columella, while its body whorl is convex, instead of concave, around the middle.

We have not seen a specimen of this species with the lip entire at the base of the aperture. In our figure 7*b* it was restored in outline below, but it is there shaded in the engraving so as to give it a somewhat unnatural appearance. As near as we can determine from the direction of the lines of growth, there is not a truncation of the columella below, though we have not been able to see exactly how it connects with the outer lip. In the figure, the engraver has also carried the inner lip too far up. It is not developed above the middle of the aperture, where it passes around out of sight.

Locality and position: Near Urbana, St. Clair county, Illinois; Upper Coal Measures. Also, near Springfield, in same position.

GENUS LOXONEMA, Phillips, 1841.

(Palæozoic Fossils, p. 98.)

We doubt the propriety of referring such forms as we here range under the name *Loxonema*, to the recent genus *Turbonilla*, Risso (= *Chemnitzia*, d'Orbigny), since they are generally not only much larger shells, but differ in not having, so far as we have been able to see, the apex of the spire reversed, as in the species upon which the genus *Turbonilla* was founded. We therefore agree with those who prefer to retain Phillips's name, *Loxonema*, for these older fossil species. It is, however, we think, generally made to include species belonging to other allied, but distinct types: *L.? compacta*, *L.? obtusa*, etc., of Hall (*Palæontology of New York*, vol. iii, pl. 54), for instance, belonging apparently to Rœmer's genus *Michelia*.

LOXONEMA SCITULA, M. and W.

Pl. 31, figs. 10*a*, 10*b*, 10*c*.

Loxonema scitula, MEEK and WORTHEN, October, 1860. Proceedings Acad. Nat. Sci., Philad., p. 464.

SHELL small, elongate-conical; spire elevated and regularly tapering; volutions eight to eight and a-half, very slightly convex, increasing gradually in size, last one rounded and not produced below; suture moderately well defined; aperture obliquely ovate, acutely angular above and rounded below. Surface ornamented by distinct, regularly disposed vertical folds or costæ, about fourteen of which occupy each turn; folds equaling the depressions between, and on the last turn becoming suddenly obsolete below the middle; no lines of growth visible. Length, 0.23 inch; breadth, 0.10 inch; length of aperture, 0.07 inch; breadth of ditto, 0.04 inch. Apical angle regular, divergence 27°.

Locality and position: Lower Coal Measures, Hodge's creek, Macoupin Co., Illinois.*

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* In first publishing this species, Springfield was by mistake given as the locality.

LOXONEMA RUGOSA, M. and W.

Pl. 31, figs. 11 *a*, 11 *b*, 11 *c*.

Loxonema rugosa, MEEK and WORTHEN, October, 1860. Proceedings Acad. Nat. Sci., Philad., p. 465.

SHELL small, elongate-conical; volutions seven and a half to eight, very slightly convex, increasing gradually in size, last one rather abruptly rounded in the middle, not extended below; suture moderately impressed; aperture obliquely ovate. Surface of each whorl ornamented by about eighteen straight, distinct, rounded vertical folds or costæ, which equal the depressions between, and are disposed so as to range in regular lines from the body whorl to the summit of the spire; those on the last whorl becoming abruptly obsolete below the middle. No lines of growth visible. Length, 0.44 inch; breadth, 0.18 inch; length of aperture, 0.12 inch; breadth of do., 0.08 inch. Apical angle convex, divergence 25°.

This shell is very nearly like the last, but differs in being less attenuate towards the summit of the spire, and in having its costæ arranged in regular rows up the spire, while those of the last are usually arranged so as to alternate on the different turns. Its costæ are also proportionally a little smaller, and somewhat more closely arranged. Notwithstanding these differences, however, more careful comparisons of other specimens examined since we first published a description of this form, lead us to suspect that it may possibly prove to be only a variety of the last, though we have not been able to fully satisfy ourselves that this is the case.

The lip of our specimen being broken, our figure does not show the form of the aperture, which must have been more rounded than the specimen figured would indicate.

Locality and position: Springfield, Ill.; Upper Coal Measures.

LOXONEMA MULTICOSTATA, M. and W.

Pl. 31, fig. 12 *a*, 12 *b*, 12 *c*.

SHELL small, conical; spire moderately elevated; volutions about seven and a half, somewhat convex, increasing gradually in size, last one forming about one-third the entire length, rounded, but not much produced below; suture well defined; aperture oval subrhombic, slightly effuse on the inner side below; outer lip thin and nearly straight; inner lip a little reflexed. Surface ornamented by small, regular, straight, vertical folds or costæ, about equaling the spaces between, and numbering near thirty on the body whorl. Costæ obsolete on the under side of the last turn; no lines of growth visible under a lens. Length, 0.36 inch; breadth, 0.15 inch; apical angle nearly regular, divergence about 28 °.

This species resembles the last two in its general appearance, but differs in having more numerous, smaller, and more closely arranged costæ. Its whorls are also more convex, and its suture deeper. It is more nearly allied to *L. scalaroidea* (sp.) of Phillips, but differs from de Koninck's figures of that species, in having perfectly straight, instead of flexuous, costæ. The number of its costæ is also less than in *L. scalaroidea*, and its spiral angle is greater than given by de Koninck in his description (22°), though less than represented in his figures (about 32°).

Locality and position: Macoupin county, Ill.; Coal Measures.

LOXONEMA CERITHIFORMIS, M. and W.

Pl. 31, fig. 13*a*, 13*b*, 13*c*.

Loxonema cerithiformis, MEEK and WORTHEN, Oct., 1860. Proceed. Acad. Nat. Sci., Philad., p. 465.

SHELL rather under medium size, elongate-conical; spire elevated, gradually tapering to an acute point; volutions eleven to twelve, convex, and increasing gradually in size; last one not much enlarged, somewhat abruptly rounded below the middle. Suture deep. Aperture oval subrhombic, a little longer than wide, apparently provided with a small notch or angularity at the base of the columella; outer lip thin, rather distinctly sigmoid in outline; columella somewhat tortuous. Surface nearly smooth, but showing under a lens very fine, obscure lines of growth, which curve parallel to the margin of the lip; just below the suture these lines are gathered into a series of minute, short, regularly arranged wrinkles or crenulations, scarcely visible without the aid of a lens. Length, 0.70 inch; breadth, 0.24 inch; length of aperture, 0.18 inch; breadth of do., 0.11 inch. Apical angle regular, divergence 24°.

In some respects this species is closely allied to *Chemenitzia subconstricta*, de Koninck (*Sup. An. Foss.*, pl. lviii, p. 17), particularly in form, and the peculiar minutely wrinkled or crenulated character of the upper margin of its whorls. It differs, however, in the form of the aperture, which is more quadrangular, and less produced below, than de Koninck's species, and the columella is also straighter. The lip of our specimen being broken, may give an unnatural appearance to the base of the aperture, but it certainly looks very much as if there had been a small oblique notch at the end of the columella, as we see in *Cerithium*. If this is natural it can scarcely be a true *Loxonema*.

Locality and position: Springfield, Ill.; Upper Coal Measures.

GENUS ORTHONEMA, M. and W.

(*Etym.*—ορϑος, straight; νημα, a thread.)

Orthonema, MEEK and WORTHEN, June, 1861. Proceed. Acad. Nat. Sci., Philad., p. 146.

SHELL elongate, many-whorled; volutions ornamented with revolving carinæ, crossed by nearly straight lines of growth; body whorl generally angular, not much enlarged or produced below; aperture angular above, slightly effuse below; peristome incomplete; outer lip simple, nearly straight; axis imperforate.

The shell upon which we proposed to found this genus has much the appearance of a *Murchisonia*, but differs in being entirely destitute of a spiral band, or a sinus in the lip, as in that genus and *Pleurotomaria*—the lines of growth being distinctly seen crossing the carinæ, and the spaces between, without making the slightest curve. In first indicating the typical species of this genus, we referred it, with a query, to Mr. Salter's genus *Eunema;* later comparisons, however, have satisfied us that it cannot be properly placed in that group, since it does not possess the peculiar sigmoid lip characterizing the forms described by Mr. Salter. It also differs in having its whorls closely contiguous at all stages of growth, while its inner lip is less developed, and its columella is not provided with a ridge or angle, as in the typical species of *Eunema*.

From the genus *Turritella*, some species of which our shell resembles in form and general appearance, it differs in its slightly effuse and less rounded aperture, disconnected peristome and straight outer lip. It is probably more nearly allied to *Loxonema* than to any of the groups we have mentioned, but presents the well marked differences of being provided with distinct revolving carinæ and a straight instead of a sigmoid outer lip and lines of growth. It will probably include several species of *Turritella*-like shells from the Coal Measures.

ORTHONEMA SALTERI, M. and W.

Pl. 31, fig. 14*a*, 14*b*, 14*c*.

Eunema? Salteri, MEEK and WORTHEN, October, 1860. Proceedings Acad. Nat. Sci., Philad., p. 464.

SHELL small, elongate-conical, acutely pointed at the apex. Volutions about thirteen, vertically flattened around the middle and sloping obliquely to the suture above, increasing gradually in size; last one angular around middle, and a little convex, but not much extended below; suture linear, rather well defined. Aperture ovate, angular above, and rounded or slightly effuse on the inner side below; outer lip thin, and nearly straight; inner lip but slightly developed; columella arcuate. Surface ornamented by three rather distinct revolving lines or carinæ, two of which occupy the upper margin of the whorls, while the third is placed just above the suture, on the spire, but passes around the middle of the last turn. Lines of growth small, rather obscure, and nearly straight from the suture until they reach the under side of the body whorl, where they arch a little forward, and then curve backwards to the base of the columella. A single revolving, impressed line is sometimes seen below the angle, on the under side of the last turn. Length, 0.50 inch; breadth, 0.17 inch. Length of aperture, 0.17 inch; breadth, 0.10 inch. Apical angle convex, divergence 23°.

Locality and position: Hodge's creek, Macoupin county, Illinois; Lower Coal Measures.

GENUS TURRITELLA, Lamarck, 1799.

(Prodr., p. 74.)

TURRITELLA?? STEVENSANA, M. and W.

Pl. 27, fig. 8 and 8a.

SHELL very small, elongate, slender, and very gradually tapering to a pointed apex; volutions ten to twelve, distinctly convex, and rather rounded, increasing gradually in size, last one forming about one-fourth the entire length—all very slightly flattened just below the suture, the flattened space being narrow and sloping outwards; suture well defined in consequence of the convexity of the whorls. Surface ornamented by small, prominent, thread-like, revolving lines or costæ, separated by impressed spaces about three times their own breadth; of these costæ, five or six may be counted on the body whorl, and four or five on each of those of the spire. Crossing all the costæ and spaces between, there may also be seen, by the aid of a magnifier, numerous minute, strongly sigmoid lines of growth. Aperture unknown. Length, 0.27 inch; breadth, 0.09 inch; apical angle very regular, divergence about 20°.

We only know this little shell from moulds left in the matrix, and our figures were drawn from wax casts made in one of these moulds, which, however, are so sharply defined as to show clearly the most minute surface markings. Judging from the form of the last whorl, it is probable the aperture is nearly circular, and the lines of growth indicate that the outer lip must be broadly retreating, near or a little above the middle (without, however, having any traces of a defined sinus), and very prominent below. The moulds also show that the under side of the last whorl is marked by small, rather crowded, revolving lines, considerably less than those above, and indicate that the columella was probably not perforated.

It is with great reluctance that we refer this little shell, even provisionally, to the genus *Turritella*, since we have good reasons for believing that that genus was not introduced until long after the Carboniferous period. As it seems, however, not to belong to any of the known palæozoic genera, and is more like the existing genus *Turritella* than any of the Mesozoic or other more modern types, we have concluded to refer it, for the present, to that group, rather than to propose for its reception a new genus, without being able to point out good characters by which it can be distinguished from *Turritella.* Its lines of growth curve much like those of *Loxonema*, from all the species of which, however, it differs in its revolving costæ. At a first glance it might be mistaken for a *Murchisonia*, but it certainly differs from that genus in having no trace of a revolving band or labial sinus.

Prof. Swallow has described, from the Coal Measures at Lexington, Missouri (*St. Louis Acad. Sci.*, 1, p. 203), under the name *Murchisonia minima*, a *very*, similar little shell, which may possibly be the same species, unless it really has the sinus in the lip, and the spiral band, of *Murchisonia*, to which, however, Prof. S. makes no allusion in his description. Dr. Stevens has also described a somewhat similar shell, under the name *Aclis minuta*, from the Upper Coal Measures at Danville, of this State (*Am. Jour. Sci.*, (2), xxv, p. 259), but his shell differs specifically in the number of its spiral costæ.

Our specific name is given in honor of Dr. R. P. Stevens, of New York City.

Locality and position: North branch Saline creek, Gallatin county, Illinois; Upper Coal Measures.

GENUS SOLENISCUS, M. and W., 1860.

(*σωληνισϰος*, a little channel or gutter.)

Soleniscus, MEEK and WORTHEN, Oct., 1860. Proceed. Acad. Nat. Sci., Philad., p. 457.

SHELL fusiform; spire pointed; whorls nearly flat, last one more or less convex in the middle, contracted and produced below into a straight canal; surface smooth, or only marked by very obscure lines of growth; aperture narrow; outer lip thin and entire; columella straight, imperforate, and provided with one sharply elevated, plait or fold.

The species constituting the type of this genus bears some analogy to the genus *Fasciolaria*, but as it differs in having only one nearly transverse fold on the columella, instead of two or three very oblique ones; while its surface is entirely destitute of nodes, costæ, or revolving markings, and its outer lip smooth within, there is little reason for supposing it to be nearly related to that group, which is unknown below the upper Cretaceous. Its texture, smooth surface, pointed spire, shallow suture, and general physiognomy, would appear to indicate affinities to *Macrocheilus* and *Polyphemopsis*; but the possession of a distinct canal, and straight columella, remove it widely from these genera. *Macrocheilus limnæiformis*, of McCoy, and *M. elongatus*, of Phillips, should doubtless be ranged in the same group with our shell.

SOLENISCUS TYPICUS, M. and W.

Pl. 31, figs. 15*a*, 15*b*.

Soleniscus typicus, MEEK and WORTHEN, October, 1860. Proceed. Acad. Nat. Sci., Philad., p. 467.

SHELL fusiform; spire rather elevated, and acutely conical; volutions seven to seven and a half, flat or but slightly convex, increasing rather rapidly in size, last one forming more than three-fourths the entire length, somewhat ventricose in the middle, and contracting rather gradually into the straight canal below; suture somewhat shallow; aperture very narrow, or lanceolate, acutely angular above, and narrowing gradually into the canal below; outer lip sharp; fold of the columella located a little below the middle of the aperture. Surface smooth or only showing very obscure traces of lines of growth. Length, 0.73 inch; breadth, 0.30 inch; apical angle slightly concave, divergence 40°. Length of aperture and canal, about 0.34 inch; breadth of former, 0.11 inch.

This interesting shell is more nearly like *Macrocheilus limnæiformis*, McCoy (*Brit. Palæozoic Fossils*, pl. 3, i, fig. 40), than any other species with which we are acquainted, but is smaller, and much less ventricose around the middle of the body whorl. The resemblance is so striking, however, that we have little hesitation in referring Prof. McCoy's species to our genus.

Locality and position: Upper Coal Measures, Springfield, Illinois.

GENUS BELLEROPHON, Montfort, 1808.

(Conch. Syst., i, p. 50.)

BELLEROPHON CRASSUS, M. and W..

Pl. 31, fig. 16 *a*, 16 *b*.

Bellerophon crassus, MEEK and WORTHEN, October, 1860. Proceed. Acad. Nat. Sci., Philad., p. 458.

SHELL large, very thick, subglobose, or a little longer than wide; volutions expanding moderately, rounded over the dorsum and sides; umbilical region somewhat excavated; mesial band narrow, rather prominent, and subangular; aperture transverse, reniform or sublunate; lip strongly thickened near the umbilical excavations on each side, but not covering them, thinner and moderately prominent in outline on each side of the narrow sinus in the outer margin, and spreading in the form of a rather thick, smooth callous, over the inner whorls, and between the callosites on each side; surface marked by rather distinct striæ of growth, and irregular, transverse wrinkles, which latter are strongest in the umbilical region and near the aperture; lines of growth and wrinkles making a very gentle forward curve in crossing from the umbilicus to the dorsal band. Greatest length, 2.26 inches; breadth, 2 inches; ditto of aperture, 1.70 inches; breadth of mesial band near the aperture, about 0.12 inch.

This fine *Bellerophon* resembles, somewhat, *B. costatus*, Sowerby, as figured by de Koninck (*Ann. Foss.*, pl. xxvi, fig. 2), but differs in having its aperture less expanded, its umbilicus more exposed, and its surface not near so regularly and distinctly costated. Its marks of growth are also much less arched backwards as they approach the mesial band, thus indicating a much smaller sinus in the lip. Our specimen is somewhat weathered, but its marks of growth appear never to have been near so strongly defined on the mesial band, as represented by de Koninck's figures of *B. costatus*.

It has more nearly the form of de Koninck's figures of *B. vasulites*, Montfort, but differs in not being regularly costate, and in having the callosites of its lip less developed in the umbilical region.

Locality and position: Pittsburg, St. Clair county, Ill.; Lower Coal Measures.

CEPHALOPODA.

GENUS NAUTILUS, Linnæus, 1758.

(Syst. Nat. Ed., 10, t. 1, p. 709.)

NAUTILUS PLANORBIFORMIS, M. and W.

Pl. 29, fig. 4 *a*, 4 *b*, 4 *c*.

Nautilus (*Discus*) *planorbiformis*, MEEK and WORTHEN, Oct., 1860. Proceed. Acad. Nat. Sci., Philad., p. 469.

SHELL of medium size, compressed-discoidal; umbilicus very wide, shallow, and showing nearly all of each inner whorl. Volutions about four, increasing gradually in size, very slightly embracing, nearly rounded in young shells, but becoming a little compressed on the sides and dorsum in mature individuals; having a row of obscure nodes around each dorso-lateral margin. Aperture slightly oval, its longer diameter being in the plane of the shell. Septa deeply concave; their margins arching gently backwards on the sides and dorsum, and separated by spaces less than one-third the transverse diameter of the whorls; siphuncle small and central; surface apparently smooth. Length or greatest diameter, 3.74 inches; height, 3.10 inches; breadth, about 1 inch.

This and the following species, together with such forms as *N. occidentalis* of Swallow, should probably constitute another subgenus distinct from *Discites* and *Trematodiscus* (see p. 161). We are rather inclined to doubt, however, the propriety of retaining either of these groups in the genus *Nautilus*, as founded upon widely different recent shells.

Locality and position: Alpine, Iowa; Coal Measures.

NAUTILUS SANGAMONENSIS, M. and W.

Pl. 29, figs. 3, 3 *a*, 3 *b*.

Nautilus (*Discus*) *sangamonensis*, MEEK and WORTHEN, Oct., 1860. Proceed. Acad. Nat. Sci., Philad., p. 470.

Compare *Discites tuberculatus*, OWEN, 1852. Geol. Report Wisconsin, Iowa and Minnesota, p. 581, tab. v, fig. 14; (not *Nautilus tuberculatus*, Sowerby, 1821).

OF this species we have seen but a single specimen, consisting of about half of one volution. It is a little wider transversely than from the dorsal to the ventral side, and increases rather gradually in size, from the smaller to the larger end, being evidently part of a discoid shell, with an umbilicus about equaling the transverse diameter of the outer whorl. On the dorsum it is nearly flat, or but slightly convex, and the sides are a little concave with an outward slope, the greatest convexity of the whorls being at the margin of the umbilicus. The ventro-lateral margins are obliquely flattened so as to form an abrupt slope into the umbilicus, leaving a subangular prominence around the margin of the umbilicus. The ventral side is moderately concave along the middle, for the reception of the inner whorls, each of which is probably about one-third hidden. On each dorso-lateral angle there is a series of rather low nodes, about twenty-three to twenty-four of which probably existed on each entire whorl.

A transverse section of the whorls is nearly quadrangular in outline, if we regard the small ventral concavity, and the two sloping ventro-lateral margins together as one side. The septa are moderately concave, and arch gracefully backwards on each side, and in the ventral depression; while they make a less distinct curve in the same direction in crossing the periphery or outer side. The siphuncle is small, and located a little nearer the outer than the inner side of the whorls. Aperture and surface markings unknown. Length, or greatest diameter, as inferred from the curve, about 2 inches; height, about 1.45 inches; breadth near the aperture, 0.88 inch.

This species bears some relations to *N. occidentalis*, Swallow, 1858(=*N. quadrangulus*, McChesney, 1860), but has more slender whorls, and its dorsum differs in being moderately convex and smooth along the middle, instead of concave and provided with two rows of nodes. Its dorso-lateral nodes are likewise less prominent, and its ventro-lateral angles differ in being destitute of any traces of nodes. The whorls of our shell are also more deeply embracing than those of the species described by Prof. Swallow. The form published by Prof. McChesney under the name of *N. nodocarinatus*, is also only a variety of the *N. occidentalis*.

Our shell is more nearly like a form referred by Murchison, de Verneuil and

Keyserling, to *N. tuberculatus*, Sowerby, in their *Geol. Russ. and Ural Mount.*, vol. ii, pl. xxv, fig. 12 *a*, *b*, but differs in having its sides flattened and sloping outwards from the prominent margins of its umbilicus, instead of inwards from the outer angles; while the nodes of its outer angles are more numerous and more crowded. According to Sowerby's and Phillips's figures of *N. tuberculatus*, the node-bearing angles are situated near the middle of each side, from which points the whorls round abruptly into the umbilicus, without any intermediate flattening of the sides. Hence our shell must differ more widely from the form upon which *N. tuberculatus* was founded, than from the Russian form alluded to. Prof. McCoy also describes *N. tuberculatus* as having the "siphuncle very large, central," while in our shell it is small and placed a little outside of the centre.

The shell figured by Dr. Owen as *Discites tuberculatus*, Owen, (*Report Geological Survey Wisconsin, Iowa and Minnesota*, tab. v, fiig. 14), is possibly identical with our species, but as Sowerby had used the same name for an allied species of this group, we cannot retain it for this shell.

Locality and position: Upper Coal Measures, Sangamon county, Illinois.

GENUS CYRTOCERAS, Goldfuss, 1832.

(Dech. in de la Beche, p. 536.)

CYRTOCERAS (APLOCERAS) CURTUM, M. and W.

Pl. 30, figs. 1 *a*, 1 *b*, 1 *c*.

Cyrtoceras curtum, MEEK and WORTHEN, October, 1860. Proceed. Acad. Nat. Sci., Philad., p. 468.

SHELL having the form of a short, moderately compressed, rapidly tapering, and slightly curved cone; section subcircular a little below the middle, but transversely oval above,—the dorsal and ventral sides being compressed, convex, and the lateral margins somewhat flattened. Surface ornamented by numerous, regularly arranged, annular striæ, or impressed lines, which arch a little forward in crossing the dorsum, where they are separated by spaces several times their own breadth, excepting near the smaller extremity of the shell. On the lateral and ventral sides these striæ become much more crowded, and more deeply impressed. Septa rather deeply concave; siphuncle small, and placed about half way between the middle and the dorsal side. Length of a specimen imperfect at the smaller end, 1.25 inches; greater diameter at the aperture, about 1.24 inches; smaller ditto, 0.92 inch; greater diameter at the smaller end, 0.54 inch; smaller ditto, 0.43 inch.

This species has somewhat the form and general appearance of *C. depressum*, Goldfuss, but is less compressed, and differs in being a little flattened on the sides; while its siphuncle is smaller, and not so near the dorsal margin. As near as can be determined by the direction of the lines of growth on our shell, it would also seem to differ in having the lip more prominent on the dorsal side. It is a very remarkable, rapidly expanding form, that may possibly belong to an undescribed genus.

Locality and position: Grayville, Illinois; Upper Coal Measures.

CYRTOCERAS? DILATATUM, M. and W.

Pl. 29, fig. 2.

Cyrtoceras? dilatatum, MEEK and WORTHEN, October, 1860. Proceed. Acad. Nat. Sci., Philad., p. 468.

SHELL broadly conical, very rapidly expanding, rather thick especially on the ventral side, slightly curved and apparently somewhat compressed on the dorsal and ventral sides. Surface ornamented by numerous, distinct, regularly arranged, subimbricating, annular marks of growth. Septa at about two inches from the smaller end, separated by spaces equaling near one-twelfth of the greater diameter of the shell at the same place. Siphuncle and form of the aperture unknown. Length of an entirely septate specimen, incomplete at both extremeties, 3.50 inches; breadth at the larger end, about 3 inches.

It is possible this may be a larger distorted specimen of the same species as the last, but with the specimens we have yet had for comparison, we cannot do otherwise than regard them as distinct. The form now under consideration differs from *C. curtum*, so far as we have been able to determine, in not being flattened on each side, and in having its lines of growth passing straighter around, instead of deflected downwards on the sides. Like the last, it can only be referred provisionally to the genus *Cyrtoceras*, from the typical species of which it differs materially in form.

Locality and position: Springfield, Illinois; Upper Coal Measures.

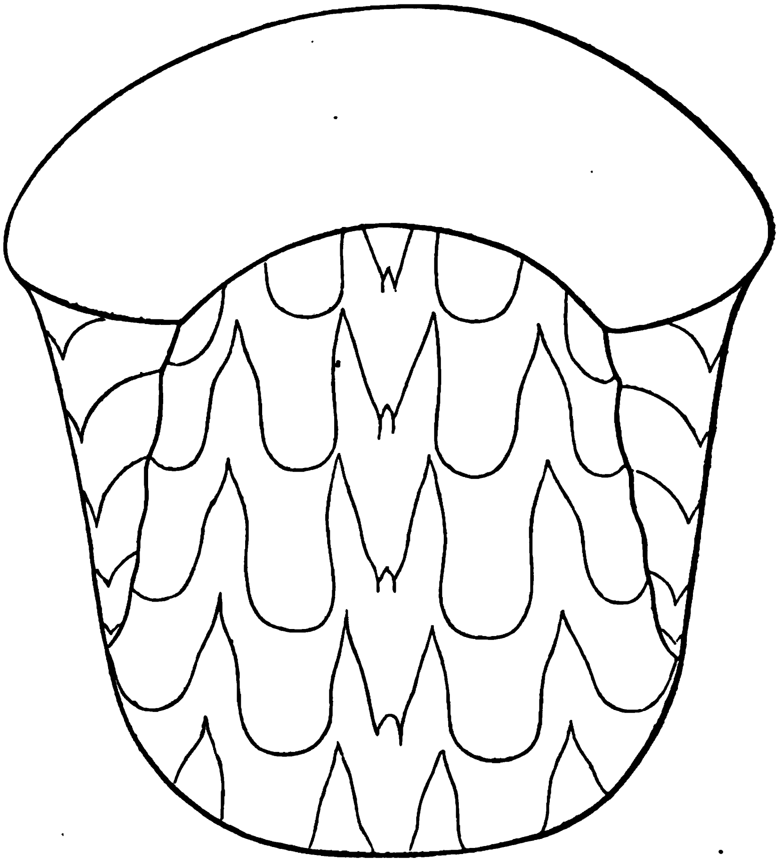
GENUS GONIATITES, de Haan, 1825. (See p. 165.)

GONIATITES GLOBULOSUS M. and W.

Pl. 30, fig. 2*a*, 2*b*, 2*c*, and accompanying cuts.

Goniatites globulosus, MEEK and WORTHEN, Oct., 1860. Proceedings Acad. Nat. Sci., Philad., p. 471.

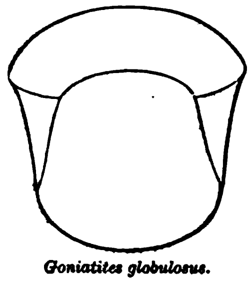
Fig. 38.



Goniatites globulosus.

Cut showing the outline and septa of a very large specimen from Eastern Kansas. Natural size.

Fig. 39.



Goniatites globulosus.

Outline of the typical specimen, natural size, to show the form of the aperture as determined from a section of the whorls.

Shell attaining a large size, length and breadth often nearly equal; very broadly rounded over the dorsum; umbilicus deep, less than half as wide as the transverse diameter of the outer whorl; volutions more than three times as wide transversely as the diameter from the dorsal to the ventral side, subangular around the margin of the umbilicus. Aperture lunate, breadth about three and a half times the dorso-ventral diameter. Surface of internal casts sometimes slightly constricted at intervals, as if from an occasional thickening of the inner lip. Septa moderately distant; dorsal lobe nearly as wide as long, and deeply divided into two slightly diverging, simple, lanceolate branches; dorsal saddle linguiform, being regularly rounded at the end, and a little narrower than the dorsal lobe, but equaling it in length, and slightly contracted in the middle; superior lateral lobe as long as the dorsal saddle, but narrower, and pointed at the extremity; lateral saddle a little broader than the dorsal saddle, which it resembles in other respects, excepting in being shorter on the ventral side; inferior lateral lobe very short, but with a pointed apex—not visible when the umbilicus is filled. Surface unknown. Length or greatest diameter, of the typical specimen, 1.18 inches; height, 1 inch; breadth near the aperture, about 1.18 inches.

Prof. Cox has figured in the *Kentucky Report*, vol. iii, pl. x, fig. 1, a shell which seems to be related to this, but from the measurements given by him it is manifest that the form he has figured is more compressed, and has a proportionally smaller umbilicus, while his diagram of a septum shows a more deeply divided dorsal lobe, with less spreading divisions. He also represents the sinus of the dorsal lobe as being pointed instead of obscurely bifid, as in our species, and the dorsal saddle pointed instead of rounded at the extremity. Our shell likewise differs in having a proportionally smaller superior lateral lobe.[*]

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[*] In making comparisons with Prof. Cox's description and diagram, it is necessary, in order to understand him clearly, that the reader should bear in mind that he has

G. sphæricus, Martin, agrees more nearly in form with our shell, but has a much smaller umbilicus, while its septa are entirely different. The septa of *G. diadema*, of Goldfuss, are very similar to those of our species, but that species has also a smaller umbilicus, and is much less ventricose than ours.

For the use of the very fine specimen from which our large outline cut No. 38 was made, we are indebted to Prof. E. Daniels. It is much larger than the typical specimens found in this State, and has the whorls a little less angular on each side, though we believe it belongs to the same species. Prof. Daniels obtained it from a clergyman in Kansas, who could give no information in regard to the locality from which it was obtained, beyond the fact that it was found in Eastern Kansas. It shows faint traces of obscure nodes on the obtuse lateral angles of the whorls.

Although our figures on plate 30 show apparently the average size of this species at the Springfield locality, we have before us a fragment from there, indicating a size of nearly half that of the Kansas specimen.

Locality and position: Upper Coal Measures, Springfield, Illinois. Also Eastern Kansas.

GONIATITES IOWENSIS, M. and W.

Pl. 30, fig. 3*a*, 3*b*, 3*c*.

Goniatites iowensis, MEEK and WORTHEN, October, 1860. Proceed. Acad. Nat. Sci., Philad., p. 471.

SHELL attaining a rather large size, discoidal or nearly flat on the sides, and narrowly rounded on the dorsum. Umbilicus rather shallow, about one-half as wide as the breadth of the outer whorl from the ventral to the dorsal side, showing apparently about one-third of each inner whorl. Volutions increasing gradually in size, but slightly convex on the sides, nearly twice as broad from the ventral to the dorsal side, as the transverse diameter, and profoundly grooved within for the reception of the inner whorls; aperture, as near as can be determined from a section of the whorls, narrow-subovate, deeply sinuous on the ventral side. (Surface unknown.)

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reversed the usual mode of describing the sinuosities of the septa. That is to say, he has described the *lobes* as *sinuses*, and the *sinuses* or saddles as *lobes*.

Septa rather crowded and deeply sinuous; dorsal lobe large, considerably wider than long, profoundly divided into two large lanceolate branches, each of which has an acutely pointed extremity; dorsal saddle linguiform, slightly oblique, a little larger than the divisions of the dorsal lobe, and longer than wide; superior lateral lobe conical or short lanceolate, as long as the dorsal saddle, but not more than half as wide, and acutely pointed at the apex; lateral saddle a little shorter than the dorsal saddle, but narrower at the extremity; inferior lateral lobe rather shorter than the superior, particularly on the ventral side, but resembling it in other respects; ventral saddle shorter than the others, and broadly rounded.

So far as we have been able to compare this fine species with figures and descriptions of those described from foreign localities, or from American rocks, it seems not to be very closely allied to any other form with which we are acquainted. It evidently attains a large size, the specimen figured by us consisting entirely of septate whorls. Length, or greatest diameter, about 4.20 inches; height, about 3.42 inches; breadth or convexity near the aperture, a little over 1 inch.

Should it be ascertained that the type of Montfort's proposed genus *Aganides*, was a true *Goniatite*, then the names of this and preceding species would become *Aganides globulosus* and *A. iowensis*.

Locality and position: Alpine, Iowa; Coal Measures.

ARTICULATA.

CRUSTACEA.

ENTOMOSTRACA.

XIPHOSURA.

GENUS BELLINURUS, Kœnig.

(Icones Sectiles, 18—, iii, p. 230.)

Not having had an opportunity to consult Kœnig's original diagnosis of this genus, nor indeed a good description of it by any other author, we are not aware what characters were assigned it, or how its author proposed to distinguish it from the existing genus *Limulus*. Most authors, including Milne Edwards, Bronn, Prestwich, Mantell, Portlock, Murchison and others, referred the species to *Limulus*, though Portlock, in doing so, remarks that the distinct trilobation and segmentation of the abdomen in these fossil species, seem to constitute a generic distinction. Pictet admits the genus in his *Traite de Palæont.*, ii, 538, and remarks that it is distinguished from *Limulus* "by the articulation of the tail, and above all by the abdominal buckler presenting two distinct longitudinal furrows." Prof. Owen also admits the genus in his valuable *Palæontology, or Systematic Summary of Extinct Animals*, p. 43, and says it differs from the "King-Crab (*Limulus*) in the movable condition of the body segments."

A careful study, however, of fine specimens of the species described below, has satisfied us that the segments of its abdomen are not movable, but as firmly and completely united into a single shield as in the genus *Limulus*. We are, therefore, led to believe that this genus is mainly distinguished from *Limulus* (so far as its characters have yet been made out) by the more transverse form of its cephalo-thoracic shield, its proportionally much longer and more slender legs,* the transverse or subcircular form and distinct trilobation and segmentation (not complete division, however) of its abdomen, as well as by its flattened borders without movable spines. There are also some differences in the more anterior position of the eyes, the stronger and more continuous character of the ocular ridges, as well as in the subdivisions of the area included by these ridges in *Bellinurus*. Other differences, of perhaps greater importance, will probably be observed, when the appendages of the under side can be seen.

None of our specimens are in a condition to show the small anterior pair of simple eyes, though from the general analogy of this interesting crustacean to the genus *Limulus*, it is more than probable better specimens may show them. And yet it is possible, from the anterior position of the eyes, corresponding to the larger reticulated pair in the genus *Limulus*, that the small supplementary pair may not have been needed. As in *Limulus*, it shows a row of six small pits in each of the longitudinal furrows of the abdomen, marking the position of the muscular apophyses within; while the condyle, for the articulation of the abdomen with the cephalo-thorax, seems to agree exactly with that of *Limulus*. We are not aware of the nature of the peculiarities in the articulation of the

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*One of our specimens of the following described species, (as well as one of *B. anthrax*, figured by Prestwich, Trans. Geol. Soc., London, v, p. xli, fig. 1), shows that at least one pair of the legs (or possibly the antennæ) must have been quite as long as the abdominal and cephalo-thoracic shields together; which would be proportionally more than twice the length of any of the legs or antennæ in *Limulus*.

caudal segment mentioned by Pictet, none of our specimens being in a condition to show the connection of that appendage with the abdomen satisfactorily, while he does not explain in what the difference consists.

BELLINURUS DANÆ, M. and W.

Pl. 32, fig. 2, 2*a*.

Bellinurus Danæ, MEEK and WORTHEN, March, 1865. Proceedings Acad. Nat. Sci., Philad., p. 43.

CEPHALO-THORACIC shield transversely crescentric, more than twice as wide as long, moderately convex, the height nearly equaling half its length; anterior and antero-lateral margins broadly and regularly rounded; lateral angles produced obliquely backwards and outwards, with a very slight inward curve, into slender mucronate spines, terminating remote from, and nearly opposite the middle of the abdomen; posterior margin on each side for about two-thirds of the way in from the lateral angles, toward the middle, concave in outline; nearly straight or very slightly concave along the middle between these points. Mesial lobe small, somewhat lower than the ocular ridge on either side, but rounded and well defined behind, where it supports a small central tubercle (or short spine?), thence narrowing forward, and sometimes showing a slight tendency to develop a second much smaller tubercle, at about one-third the length of the shield from its posterior margin—near which point it suddenly contracts into a mere linear carina, that extends forward to the anterior transverse division of the ocular ridge. Area included by the ocular ridge, crown-shaped or subquadrangular in outline, and composing the central third of the cephalo-thoracic shield; a little wider anteriorly than its length, which equals about five-sixths that of the shield; lateral margins concave in outline; anterior side convex, with a central emargination; internal surface divided into four irregular subordinate areas, by the mesial lobe with its linear anterior continuation, and a less distinctly defined, secondary transverse linear ridge. Ocular ridge narrow, but distinct, its lateral divisions arching inwards behind the eyes, and terminating posteriorly at the margin of the shield, nearly opposite the middle of each lateral lobe of the abdomen, in a (triangular) spine? which is directed backwards, outwards, and a little upwards; anterior transverse division arching forwards on each side, and curving backwards in the middle. Compound eyes small, remote and located one at each antero-lateral angle of the crown-shaped central area, at points about one-third the length of the shield from its anterior margin. Sim-eyes, if they existed, unknown.

Abdomen transversely suboval, being wider than long, and nearly straight anteriorly, with lateral margins, rounding in abruptly in front, and more gradually into the regularly rounded posterior outline; generally rather more depressed than the cephalo-thorax, particularly in front. Flattened lateral border rather narrow, and regularly scolloped between its projecting marginal spines. Mesial lobe narrow, or of about the same breadth as that of the cephalo-thorax, and near half as broad as, and a little more elevated than, the lateral lobes; segments well defined; first and third each provided with a small central tubercle; sixth as long as any three of the others, rather abruptly narrowed and depressed behind, and surmounted anteriorly by a large tubercle (or spine?). Lateral lobes somewhat flattened on the inner half, and rounding down rather abruptly to the flattened free borders on each side and behind; segments defined by distinct linear ridges, which are separated by flattened spaces four or five times as wide; these ridges extend obliquely outwards and a little backwards across the lateral lobes and their flattened borders, beyond which they are produced into slender mucronate spines, of nearly equal length, curved obliquely backwards.

Telson apparently nearly two-thirds as long as the abdomen, gradually tapering, and trigonal or subtrigonal, being flat below, angular on each side, and angular or rounded above.

Appendages of the under side unknown, excepting one of the legs, which is seen in one specimen, projecting out from under the cephalo-thoracic shield, between its posterior margin and the abdomen. It is slender, and shows of the first segment projecting from under the shield, a length of about 0.12 inch. The next segment appears to be 0.25 inch in length, with a breadth of only 0.04 inch. The succeeding segment can be traced in the matrix for a distance of about 0.30 inch, being slightly curved near the extremity, and apparently tapering to a point, but the specimen is not in a condition to show its termination. It is not possible to determine which one of the legs this is. Entire length, from the extremity of the caudal segment to the anterior margin of the cephalo-thorax, about 1.90 inches. Length of cephalo-thorax, 0.57 inch; breadth of do. to the extremities of postero-lateral spines, 1.70 inches; length of area included within the ocular ridge, 0.50 inch; greatest breadth of do. (which is the distance between the eyes), 0.60 inch. Length of abdomen, 0.65 inch; breadth of do., exclusive of the flattened margin, 0.94 inch, including it, 1.06 inches; breadth of mesial lobe, 0.23 inch; length of caudal segment, about 0.60 inch.

Of the known species of *Bellinurus*, ours seems to be most nearly related to *B. bellulus*, Kœnig (the type of the genus, if we mistake not), which is regarded as being identical with *Limulus rotundatus*, of Prestwich, (*Trans. Geol. Soc.*, London, v. p. 491, pl. xli, figs. 4, 6 and 7.) From this species, however, it may be at once distinguished by having the lateral angles of its cephalo-thorax produced into long, slender spines, and the flattened border of its abdomen proportionally much narrower, and armed with a series of sharp-curved spines, instead of being merely serrated.

We should also remark here, that Prof. Owen's figure of *B. bellulus* (*Palæontology*, p. 42), as well as that given by Murchison of the same, under Prestwich's name *rotundatus* (*Siluria*, p. 281), represent the eyes as being located at the lateral extremities of a large, transversely oval or subelliptical area; while within this there is a smaller, crown-shaped area, defined by a ridge, and in all its principal features corresponding to that which in our species has the eyes located at its anterior lateral angles. This wide difference in the position of the eyes, as well as in the ridges of the central region of the cephalo-thoracic shield, if they really exist, would apparently be of more than specific importance. The close general agreement, however, of these forms, in all their other essential characters, renders it very improbable that they belong to different genera. Hence, we would suggest that there may have been some error in the figures cited above, representing the eyes (which are with difficulty seen in any but well preserved specimens) in this outer position, and the presence of a large outer ocular area surrounding that corresponding to the quadrangular one in our species. We are the more inclined to think this is the case, from the fact that Owen's and Murchison's figures appear to have been reduced from Prestwich's figures 5 and 6, cited above, which represent the two halves of a nodule, containing a specimen and its mould, of *B. bellulus*, with a large transversely oval space in the central region of the cephalo-thorax, as we must think, *accidentally crushed in.* This view seems to be sustained, too, by Mantell's figures of the same species, from specimens collected by him at the same locality (see *Medals of Creation*, p. 550), which show no traces of this outer transversely oval ocular area.

In the elongated, spine-like character of the lateral angles of its cephalo-thoracic shield, as well as in having the margins of the abdomen armed with sharp spines, our species agrees more nearly with *B. anthrax*(=*Limulus anthrax*, Prestwich), but it differs in the form of the outline of the anterior side of the cephalo-thorax, as well as in the direction of its prolonged lateral angles, and its less produced spines around the flattened margins of the abdomen. Hence, it appears to be intermediate in its characters between *B. anthrax* and *B. bellulus.*

This fine species, the first of the genus discovered in America, was with great pleasure dedicated by us to Prof. James D. Dana, the author of one of the most important works on the Crustacea ever published; to whom we are indebted for the loan of one of the specimens from which the foregoing description was drawn up.

Locality and position: Morris, Grundy county, Illinois; near the base of the Coal Measures.*

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* By an oversight, the position of the *Batrachian* described from this bed, on p. 135, is wrongly given, in a note at the bottom of that page, as *above the middle of the Coal Measures.*

TETRADECAPODA.

ISOPODA.

(ANISOPODA.)

GENUS ACANTHOTELSON, M. and W.

Acanthotelson, MEEK and WORTHEN, October, 1860. Proceed. Acad. Nat. Sci., Philad., p. 457.

SUPERIOR antennæ nearly as long as the inferior, and provided with well developed accessory appendages; flagella of both pairs longer than the peduncles; head about equaling the length of the first two anterior thoracic segments. Thoracic and abdominal segments (excepting the last one) not differing materially in length, and each shorter than the head. Anterior thoracic legs longer than the others, not chelate?. Telson or terminal segment simple, long, spine-like, and laterally compressed. Stylets with second segments (double?) much longer than the first, and similar to the telson.

The fact that the oral apparatus, and other appendages of the head, as well as the branchiæ, always so important in the classification of the Crustacea, are so rarely preserved in fossil species, especially those of smaller sizes, renders their study more difficult than that of most organic remains. Hence, in describing new species, genera, or other groups, the palæontologist is often unable to give any information in regard to the very parts that would be the first to claim the attention of the Carcinologist in the investigation of recent species. Another difficulty also arises from the fact that, as in other departments of palæontology, it often happens in the study of fossil crustacea, that we meet with types presenting a combination of characters which in existing species are distributed in widely distinct groups. So that on finding a new type showing only a part of its characters, we would often be led at once to place it in a group with which probably the next specimen found would show it to possess some one or more wholly incompatible peculiarities.

On first examining specimens of the typical species of the genus above described, our impression was, that it must be, beyond all doubt, a true *Amphipod.* A more careful examination, however, soon showed that it presents the radical difference from all the known types of that extensive group, of having only one pair of the abdominal appendages, styliform, and the other five natatory, instead of three pairs styliform and three natatory; thus combining with its Amphidodan abdomen, thorax, head, anterior appendages, and general physiognomy, the single pair of styliform appendages of the *Isopoda*.

Being therefore left in doubt in regard to its affinities, we sent sketches of some of the best specimens to Prof. Dana, who had also previously received some imperfect specimens of the same species from Illinois. On examining these sketches and specimens, Prof. Dana wrote that he thinks this crustacean most probably belongs to a group holding an intermediate position between the typical *Isopoda* and the *Amphipoda*, for which he has proposed the name *Anisopoda*. This intermediate group, as first shown by Prof. Dana, is characterized like the *Amphipoda*, by having the three posterior pairs of thoracic legs in one series, and the four anterior in another; while, as in the *Isopoda*, the branchiæ are abdominal, and only one pair of abdominal appendages are styliform, and five branchial.

In regard to the division of the thoracic legs into two series, we would remark, that we have observed no evidence of it in all the specimens we have seen, excepting one of those kindly loaned us by Prof. Dana. In this, however, *four* pairs of these legs seem to be directed backwards, and only *three* forward; which, if not produced by accidental distortion, would indicate *Isopod* affinities. Yet, in all the other specimens seen, the whole seven pairs are directed forward. Although much inclined to believe the latter their normal arrangement, it should be remembered, as suggested by Prof. Dana, that however important this character may be in the study of the recent Tetradecapod crustacea, it can scarcely be made available in the investigation of crushed fossil species, where so many accidents might have occurred to place the legs in an unnatural posture.

We have not been able to clearly satisfy ourselves whether or not our crustacean had squamiformly developed epimerals, as in the normal groups of *Amphipoda*; though some of the specimens appear to show indications of such development; while the shortening of the vertical diameter of the thoracic segments, as compared with those of the abdomen, would seem to be, as it were, an arrangement to make room for such scale-like epimerals. In addition to this, the fact that all of the six or eight specimens we have yet seen, lie in the concretions upon one side or the other, would appear to indicate that the lateral motion of the thoracic legs was in some way restrained so as to prevent the animal from taking an erect posture, which is precisely the effect produced in the normal *Amphipoda* by the possession of well developed squamose epimerals. If this should prove to be the case, it would show that the remarkable combination of *Amphipod* and *Isopod*, or *Anisopod* characters, already alluded to in this fossil, are real, and not simulative; since it would thus present mainly the anterior structure (possibly even to the thoracic position of the branchiæ) of a normal *Amphipod*, combined with the single pair of styliform, and five natatory abdominal appendages of the *Isopoda* or *Anisopoda*.

It must be evident, we think, that such an ensemble of characters as that presented by our fossil, would exclude it from any known family of the *Tetradecapoda*; hence we can but regard it as the type of a new family, *Acanthotelsonidæ*.

ACANTHOTELSON STIMPSONI, M. and W.

Pl. 32, fig. 6, 6*a* to 6*f*.

Acanthotelson Stimpsoni, MEEK and WORTHEN, March, 1865. Proceed. Acad. Nat. Sci., Philad., p. 47.

LINEAR or sublinear in form. Upper antennæ at least as long as the head and first five thoracic segments; peduncle moderately stout, rather longer than the head; first joint a little longer and wider than the two others, which are of nearly equal length; flagellum slender and very minutely jointed; accessory appendage nearly or quite as long as the flagellum, and like it, minutely jointed. Inferior antennæ as long as the head and seven thoracic segments; peduncle slightly longer, but otherwise similar to that of the upper antennæ; flagellum a little stouter and longer, but in other respects as in the upper pair. Head, as seen in the (compressed) side view, subquadrangular, longer on the upper than the lower side, in consequence of the obliquity of the anterior side; eyes small, round, placed just below the bases of the upper antennæ. The (fourteen) thoracic and abdominal segments distinct, and (excepting the last one) of nearly equal length—a few of those nearest the head being a little shorter than the others; all diminishing in depth (side view) from about the antepenultimate one forward; their anterior basal margins rounded; posterior rectangular or a little rounded.

First pair of thoracic legs about one-fourth longer and a little stouter than the succeeding five pairs, and apparently terminating in a slender, sharp dactylus; first joint above a little shorter, narrower, and more tapering than the next—neither more enlarged than the others above. Five succeeding pairs of legs of nearly equal size and form; their upper two (or three?) segments very short, and not enlarged; seventh pair nearly as long as the first, and more slender than the others. Natatory abdominal appendages long and slender; styliform pair with first segment short and quadrangular; second and only other joint (double?) with each branch (if there are two) simple, equal and as long as the telson, which they nearly exactly resemble in form; their upper and lower margins each with a row of short, oblique, rather distant setæ, between which may be seen, by the aid of a magnifier, a series of much more minute, closely-arranged setæ. Telson as long as the last four abdominal segments; at its base one-half as wide vertically as the penultimate abdominal segment; thence tapering, at first rapidly and then very gradually, to a mucronate point—upper and lower margins setigerous, like those of the stylets.

It is possible that when we can have an opportunity to examine additional specimens, we may have to modify some of the characters given in the foregoing generic or specific description; though not, we believe, in any very essential particular. We hope, however, to be able hereafter to add other characters, and to clear up several doubtful points in the structure of this interesting type, when we can have better specimens for study.

Length from anterior side of head to the extremity of the penultimate abdominal segment, 1.30 inches; length of telson, 0.31 inch; length of the first six abdominal segments, 0.52 inch; length of the seven thoracic segments, about 0.64 inch. Height of third abdominal segment, 0.20 inch; height of each first two or three thoracic segments, 0.12 inch; length of stylets about 0.31 inch.

Locality and position: Same as preceding.

ACANTHOTELSON INÆQUALIS, M. and W.

Pl. 32, fig. 7, 7*a*.

Acanthotelson inæqualis, MEEK and WORTHEN, March, 1865. Proceed. Acad. Nat. Sci., Philad., p. 48.

THE specimen upon which we proposed to found this species appears to agree with the last in almost every respect, excepting in the proportional size and the form of the segments. In the first place, the penultimate abdominal segment is nearly twice the length of any of the others, instead of being nearly or quite of the same length; while the other abdominal segments (as seen in a side view) are more cuneiform than in the last. Again, the fifth and sixth thoracic segments are longer, particularly above, and the fourth shorter, than any of the others, instead of all being of about the same length. We have not been able to see the stylets, nor to make out the nature of the legs; but from a part of one of those of the anterior pair, they would seem to be rather stouter than in the last described species.

As these differences can scarcely be due to accidental distortion, we can but regard this form, with the material now at hand for comparison, as a distinct species. If we are correct in this view, it is probable good examples will show other differences than those mentioned above.

Length of head, thorax and abdomen, 0.90 inch; length of head, 0.12 inch; length of the seven thoracic segments, about 0.50 inch; length of first five abdominal segments, 0.26 inch; length of penultimate abdominal segment, 0.09 inch. Height of third abdominal segment (flattened side view), 0.13 inch; height of anterior thoracic segments, about 0.07 inch. Length of lower antennæ at least 0.43 inch; length of upper not less than 0.36 inch, and probably a little more.

Locality and position: Same as last.

GENUS PALÆOCARIS, M. and W.

(παλαιος, ancient; καρις, a shrimp.)

Palæocaris, MEEK and WORTHEN, March, 1865. Proceed. Acad. Nat. Sci., Philad., p. 48.

INNER and outer pairs of antennæ of nearly equal length, the former each bearing a well developed accessory appendage; peduncles of both pairs shorter than the flagella. Head about as long as the first two abdominal segments. Thoracic legs long and slender; anterior pair not chelate. Telson long, tapering and horizontally flattened; stylets with first joint very small, second double, and also flattened horizontally.

This is another remarkable type, presenting, so far as can be determined, even a more puzzling combination of characters than that we have described under the name *Acanthotelson*. In the nature of its antennæ, with their apparently well developed basal scales, the structure of its caudal appendages, and its long, slender legs, spread out on each side, for walking in an erect attitude; as well as in the depressed, slender form of its abdomen and thorax, it seems to present decidedly the aspect of a Macrural Decapod. Yet, on a closer examination, we can see no traces of a carapace, the thorax being apparently divided into seven segments, like those of the abdomen, and each provided with a pair of legs, as in the *Tetradecapoda*. If we are not mistaken in these latter characters, and we certainly believe we are not, it must show a most extraordinary union of characters, which, amongst recent crustacea, belong to different primary divisions. From all that can be made out of its structure, we are therefore inclined to view it as one of the "embryonic" or "comprehensive" types, so often met with in various departments of palæontology, and which furnish the advocates of the Darwinian hypothesis with some of their strongest arguments.

For the present, this genus is placed, provisionally, along with the *Tetradecapoda*, though it cannot, we think, be included in any known family of that division; while if it should prove to be an embryonic or low type of the *Decapoda*, it may be even necessary to establish for its reception a division of more than family importance. It is proper to remark here, however, that we have not seen any one specimen showing the caudal appendages we have described, united with the other characters of the thoracic and cephalic members, mentioned above. One imperfect specimen shows the seven thoracic and five or six of the abdominal segments, with their legs and natatory appendages, the head, antennæ, and apparently their basal scales; while another shows the caudal appendages, and all of the thoracic and abdominal segments, very distinctly, without any of the other members. The general agreement, however, of these specimens, in the parts preserved in each, is such that scarcely a doubt can be entertained, that they belong to the same species. Yet, in order to prevent confusion, we would remark, that in case they should prove to belong to different genera, or species, that it is the form showing the head, antennæ, thoracic and abdominal segments, with their appendages, &c., that we regard as the type of the genus and species.

PALÆOCARIS TYPUS, M. and W.

Pl. 32, fig. 5, 5*a*, 5*b*, 5*c*, 5*d*.

Palæocaris typus, MEEK and WORTHEN, March, 1865. Proceedings Acad. Nat. Sci., Philad., p. 49.

LINEAR, with thorax slightly wider near the middle than the abdomen; thoracic and abdominal segments of nearly equal length. Inner antennæ equaling the length of the head and thorax; peduncles stout, first joint a little longer and wider than either of the other two, which are of nearly equal length, and minutely and closely setigerous on their inner margins; flagellum very slender, and minutely jointed; accessory appendage nearly or quite as long as the flagellum, and scarcely differing from it otherwise. Outer antennæ possibly a little longer than the others, peduncles slightly longer than those of the other pair, and like them minutely setigerous in front; basal scales (?) oblong, about as long as first joint of peduncles, squarely truncated. Thoracic legs slender and long, anterior ones apparently not longer or larger than the others, none of them (so far as can be seen) chelate, or with any of the segments enlarged; all the others with the first two or three joints very short; fourth? joint horizontally extended, tapering, and about as long as four segments of the body; succeeding joints (in the specimen examined) very slender and abruptly bent downwards and backwards. Natatory abdominal appendages acutely lancelinear, and some of them as long as four of the abdominal segments. Telson nearly as broad at the base as the penultimate segment, tapering, and as long as two and a half of the abdominal segments; minutely setigerous on each side. Stylets, with first joint very minute; second with each division as long as the telson, and lancelinear in form, with pointed extremities, and parallel, more or less setigerous margins. Length of head, thorax and first six abdominal segments, 0.78 inch; do. of head, 0.12 inch; do. of the seven thoracic segments, 0.35 inch; do. of the first six abdominal segments, about 0.31 inch. Length of telson, about 0.14 inch; do. of stylets, near 0.13 inch. Length of lower or outer antennæ, not less than 0.38 inch (probably more), of which the peduncle forms 0.15 inch; do. of inner, 0.40 inch. Breadth of thorax, 0.13 inch.

Locality and position: Same as preceding.

DECAPODA.

MACRURA.

? GENUS ANTHRAPALÆMON, Salter.

Anthrapalæmon, SALTER, 1861. Quart. Jour. of Geol. Soc. of London, xvii, p. 529.

"Carapace scarcely so broad as long, (except when crushed flat), simple, flatter than semicylindrical, the sides a little arched outwards. A strong central ridge in front, projecting as a thick (serrate ?) spine is separated by a concave space, or slight furrow, from a posterior central ridge, which only occupies (in the type species, *Grossarii*) a small portion of the length. Front margin serrated. The outer antennæ have wide, square, basal joints, apparently *without any advantage*;* the second and third joints not much oblique; the rest about as broad as long. Abdomen as broad as long, of six joints (besides the telson), broad and very short; the pleuræ, except the second, pointed. Telson very broad; appendages to the penultimate joint, double on each side, subtrigonal, broad."—(Salter.)

The name *Anthrapalæmon* was proposed from its supposed affinities to the recent genus *Palæmon*, but Prof. Dana thinks it more nearly related to *Æglea* and *Galathea*. The original type of the genus was found in the Coal Measures of Scotland.

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* Is this not a misprint of the word *appendage*?

ANTHRAPALÆMON GRACILIS, M. and W.

Pl. 32, fig. 4, 4*a*, 4*b*, 4*c*.

Anthrapalæmon gracilis, MEEK and WORTHEN, May, 1865. Proceed. Acad. Nat. Sci., Philad., p. 50.

It is with considerable doubt that we venture to refer this species to Mr. Salter's genus, the only specimen we have seen being imperfect, and not in a condition to show the more important characters. In form and general appearance, however, as well as in such of its details as can be made out, it seems to agree well with that genus. The specimen consists of the abdomen and caudal appendages (in a crushed condition), and an impression in the matrix of the under side of the carapace, the outer pair of antennæ, and apparently of the eyes. The carapace, as seen from above, presents nearly an oblong form, excepting that the lateral margins are moderately convex in outline; the two extremities are truncated, and the breadth nearly or quite equaling three-fourths the length. Its lateral margins, in front of the middle, are each finely serrated by six small, sharp, projecting points, as in the type of the genus, excepting that they are sharper and directed more obliquely forward. At each antero-lateral angle there is also a considerably larger projecting point, forming a short spine, exactly as in the type of the genus, excepting that it is extended more nearly directly forward. The outer pair of antennæ are moderately stout, each peduncle showing three joints, diminishing rather gradually in size, the first longer than wide and the other two apparently of nearly equal length and breadth, and obliquely articulated. The flagellum is narrower at its base than the last joint of the peduncle, and composed of very short segments, which are scarcely more than one-third as long as wide. The entire length of the antennæ can not be determined, as neither flagellum is entire in the specimen examined; but as the portion remaining tapers very gradually, they were probably rather long. They are both, in the specimen examined, deflected abruptly outwards, nearly at right angles to the longer diameter of the carapace, which would seem, from the oblique articulation of the second and third joints of the peduncles, to be their natural position. (Inner antennæ unknown.)

Immediately between the bases of the two outer antennæ, the specimen shows what appear to be impressions of the two globose eyes, which with their peduncles extend forward about two-thirds as far as the peduncles of the antennæ. These may possibly be the peduncles of the inner antennæ; but they look very much like globular eyes, on more slender peduncles.

The abdomen is more than half the length and about two-thirds the breadth of the widest part of the carapace. It shows five short segments and apparently part of another, the first of which is a little smaller and the second a little larger than the others. None of them, however, are more than one-fifth as long as the breadth of the abdomen.

The caudal appendages being unfortunately bent down and crushed, it is not possible to make out the form of the telson or the details of the other parts, though the whole together seem to have been wider than the abdomen, and as wide as the carapace. No surface sculpturing can be clearly made out, though there is some appearance of a few irregular scattering granules near the margins of the carapace. (Other parts unknown.)

It will be observed, from the foregoing remarks, that our specimen shows no traces of the central spine or beak, extending forward from the anterior extremity of the carapace, nor of the longitudinal carina connected with it, which constitutes such a marked feature in *Anthapalæmon*. It is possible, however, that this character may have been obliterated in breaking open the concretion, since our specimen only shows an impression of the under side of the carapace, while the appendage alluded to projects forward from the upper side, and may consequently be imbedded in the other half of the concretion, which we have been unable to obtain. Still, as it is possible that this appendage may be wanting in our fossil, we should not be surprised if it would prove to belong to an allied but distinct genus.

Specifically, at least, it differs from *A. Grossarii*, of Salter, in the proportionally much shorter joints of the flagella of its outer antennæ and the oblique articulations of the segments of their peduncles; while the latter, as well as the surface of other parts, are without any traces of the fine pitting represented by Mr. Salter's figures. Our specimen also shows traces of what appear to be squarely truncated basal scales to the outer antennæ, about as long as their first joints, while Mr. Salter's figure (1) represents apparently a triangular scale over one of the antennæ.

Length from the end of the caudal extremity to the anterior margin of the carapace, 1 inch. Length of carapace, 0.60 inch; breadth of do., 0.43 inch. Length of abdomen, about 0.30 inch; breadth of do., 0.27 inch. Length of caudal appendages, 0.10 inch.

Locality and position: Same as preceding.

MYRIAPODA

?GENUS ANTHRACERPES, M. and W.

(*ανϑραξ*, coal; *ἑρπω*, to creep;—in allusion to its Carboniferous age, and probable habits.)

ANTHRACERPES TYPUS, M. and W.

Pl. 29, fig. 1, 1 *a*.

Anthracerpes typus, MEEK and WORTHEN, May, 1865. Proceed. Acad. Nat. Sci., Philad., p. 51.

THIS genus and species were founded upon a slender worm-like fossil, the relations of which have not been very clearly determined. The specimen consists of a well defined mould or impression left in a concretion, and measures 1.50 inches in length, and about 0.09 inch in breadth (height), as seen lying upon one side. It is regularly arched from end to end, so as to form about one-third of a circle of 0.65 inch radius. For most of its length, it is of very uniform breadth or height, but it tapers very gradually towards what appears to be the posterior end, where the last segment terminates in three or four short, slender, hair-like, or spine-like appendages, directed backwards on a line with the general curve of the body. The other end being broken away in the only specimen yet known, the nature of the head and its appendages cannot be determined.

The entire body is distinctly articulated, and shows clearly nineteen segments, and part of another. The segments are of nearly uniform size, or only vary from 0.08 to 0.10 inch in length; the last one, however, has only a breadth or height of about 0.03 inch, and the next about twice that. Crossing the segments near the upper side, may be seen in the mould an undefined furrow (produced by a ridge in the fossil itself), which bends downwards and then up again as it passes across from side to side of each segment. Anteriorly it is less distinct and placed very near the dorsal margin, but in tracing it backwards it is found to descend and become more defined, until it reaches the fourth segment from the extremity; on this it passes obliquely downward to its posterior inferior corner, so as not to be seen on any of the succeeding divisions behind. Below the middle of each segment, there is in the mould a small prominence, evidently marking the position of a corresponding pit in the fossil. These agree in position and appearance with the spiracles or breathing apertures in the *Myriapoda*. We have not been able to make out very clearly, any indications of feet or other appendages; though there is near the base of each segment of the mould, a short oblique impression, that may possibly have been left by very small, feeble legs folded backwards.

As this fossil shows too many segments for a larval Insect, and has not the aspect of an Annelid, we are rather inclined to view it as a Myriapod.

Locality and position: Same as preceding.

INSECTA.

LEPIDOPTERA.

GENUS PALÆOCAMPA, M. and W.

(*παλαιος*, ancient; *καμπη*, a caterpillar.)

PALÆOCAMPA ANTHRAX, M. and W.

Pl. 32, fig. 3.

Palæocampa anthrax, MEEK and WORTHEN, May, 1865. Proceed. Acad. Nat. Sci., Philad., p. 52.

The fossil for which the above generic name is proposed, is about 0.90 inch in length, and some 0.13 inch in breadth, exclusive of the projecting tufts of hairs. It is an arcuate, worm-like body, that has been divided or split lengthwise in breaking open the concretion in which it is enveloped; so that it is only a longitudinal section we see in looking at either half of the concretion. At both extremities, and along the upper or convex side of the curve, we observe densely packed tufts or fascicles of hairs individually radiating, as if from small, wart-like protuberances. These hairs are straight, and about 0.30 inch in length. At one extremity, which appears to be the anterior, two of the bundles of hairs are more radiating than the others, and directed forward. The bundles distributed over the curved or dorsal side are regularly arranged, and have each a general direction at right angles from the part of the arched side from which they spring. At the posterior extremity there are also two tufts directed backwards, the individual hairs of which are less radiating than those at the other extremity. Between some of the bundles ranged along the upper side, some shorter tufts are seen, which appear as if they originate in another series of protuberances farther over on the other side embedded in the matrix. If we suppose each of these principal bundles along the curved side, and the two bundles at either end to each belong to a single segment, it would make about ten or eleven segments to the entire body.

The specimen is not in a condition to show the head or feet; yet we are strongly inclined to believe from its form, and peculiar, regularly arranged bundles of hairs, that it is a CATERPILLAR. If we are right in this suggestion, its discovery is certainly an interesting one, as it would present an evidence of the existence of *Lepidopterous* Insects, at a much earlier period in our world's history than has hitherto been suspected.

As this fossil will doubtless be met with in the Coal Measures at other localities, whether or not its relations to the mature Butterfly or Moth can ever be positively established, it seems desirable for convenience of reference, that it should receive a name; although we are unable to point out any well defined characters from the only specimen seen, by which it can be distinguished from the larva of several existing types. That there is any probability, however, of its belonging to any existing genus, will, we think, not be maintained by any person familiar with the range of generic types of Insects in time.

Locality and position: Same as last.

SUPPLEMENT TO DESCRIPTIONS OF INVERTEBRATES.

DESCRIPTIONS OF POLYZOA FROM THE PALÆOZOIC ROCKS.

BY H. A. PROUT, M. D.*

COSCINIUM WORTHENI, Prout.

Pl. 22, fig. 1.

Coscinopora Wortheni, 1860. Proceed. St. Louis Academy of Science, vol. 1, p. 571.

POLYZOUM a leaf-like expansion, with a zig-zag midrib, elevated much above the declining sides of the expansion; having lateral branches given out at its salient points, which are likewise raised above the declining surfaces proceeding from it, and which, as they proceed downward, change at right angles to the original planes of expansion. Dimples long, elliptical; longitudinal diameter five to seven and a-half; transverse, one to one-half m. m., oppositely pinnate both on the branches and midrib, about four m. m. apart. Cells large, about four longitudinally or transversely in the space of two m. m.; lips round, thickened on the lower border, but not distinctly nasiform; direction of the cells, slightly upward and outward to the plane of the surfaces from the midrib, being only slightly modified by the elevation of the lateral branches. Intercellular spaces, or net work, minutely capillary, as this tissue is developed from the approximating and receding ridges of the sole.

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* These descriptions were originally published by Dr. Prout in the Transactions of the St. Louis Academy of Science. Had he lived to revise them for this Report, he would doubtless have modified them in some respects, but as we have not at hand all the specimens before him at the time he drew up the descriptions, we have thought it better to give them as first written by him. M. and W.

This species is dedicated to Mr. A. H. Worthen, State Geologist of Illinois, whose indefatigable labors in the field, and whose zeal and devotion to the interests of science, promise a rich harvest to Western Geology, and through whose kindness and liberality we have been permitted to describe this and the following species of Polyzoa.

Geological position and locality: Keokuk group, near Warsaw, Illinois.

COSCINIUM ELEGANS, Prout.

Pl. 22, fig. 2.

Coscinium elegans, PROUT, 1860. Proceed. St. Louis Acad. of Sci., vol. i, p. 572.

POLYZOUM a leaf-like expansion between what seems to be a wide bifurcation of the midrib, rythmical dimples from each branch pointing at first obliquely toward each other, meeting irregularly toward the middle, and anastomosing towards the superior border, which is reflected upon itself by compression. Dimples small, sharp and pointed, sometimes long; longitudinally, or transversely, there are from five to six in a space of twenty m m. Cells large, almost visible to the naked eye, with two prominent rounded lips, on the border of the dimples they seem larger, and give to it a notched appearance.

Though the measurements in this species are very nearly the same as in *C. Keyserlingi*, from the Keokuk group, we are inclined to refer it to a distinct species, from the narrower, longer and more pointed dimples which are lanceolate, while in *C. Keyserlingi* they are broader and more oval; this, together with the difference in the surface distribution of the dimples, will, it is believed, warrant the distinction.

Geological position and locality: Lower beds of the St. Louis group; Warsaw, Illinois.

COSCINIUM PLUMOSUM, Prout.

Pl. 22, fig. 3, 3 *a*.

Coscinium plumosum, PROUT, 1860. Proceed. St. Louis Acad. Sci., vol. i, p. 572.

POLYZOUM an irregular, leaf-like expansion, midrib sharp, crust-like, raised irregularly above the surface, more or less alternately branching, the spaces between the branches being more or less concave, and rising upon their outer borders to be united with other concave expansions from other branches. Where the expansions are large, the long, narrow, rythmical dimples, and corresponding ridges between them, are sometimes curved like long plumes, gracefully waving over one another, but the distribution of the dimples is mostly irregular, from the irregular growth of the polyzoum. In one specimen, belonging to my own cabinet, the opposite face of the polyzoum is broken up into cup-shaped cavities about the size and shape of those which characterize the *Michelinia favosa*, Koninck. These cup-shaped cells are bounded by interstitial plates, with thin, salient and entire lips, denuded of chalices near the margin, and are marked by rythmical and abortive spaces, occasionally towards the centre. Sometimes this cupuliferous expansion is found separate from the wider and more plumose form of the polyzoum, and would, by those who are not careful in distinguishing forms, be most probably referred to *Michelinia*.

Geological position and locality: Lower beds of the St. Louis group; Warsaw, Illinois, and Barrett's Station, St. Louis county, Missouri.

COSCINIUM MICHELINIA, Prout.

Pl. 22, fig. 4.

Coscinium Michelinia, PROUT, 1860. Proceed. St. Louis Acad. Sci., vol. i, p. 573.

POLYZOUM encrusting, extending over a considerable surface, divided into larger or smaller, more or less hexagonal, cup-shaped cavities, with salient tuberculated lips, bottoms of the cups having sometimes deep lanceolate, or oval depressions; interior surfaces marked with irregular ridges covered by cell pores or chalices, leaving occasional abortive spaces between them. This is separated from the preceding species on account of its more robust growth, the irregular notched or tuberculated form of the lid, and the other characters assigned to it above. The thin and salient lips of the *plumosum* would scarcely assume the tuberculated form in a regular development of the polyzoum.

Geological position and locality: Lower beds of the St. Louis group; Warsaw, Illinois.

COSCINIUM SAGANELLA, Prout.

Pl. 22, fig. 5.

Coscinium saganella, PROUT, 1860. Proceed. St. Louis Acad. Sci., vol. 1, p. 572.

POLYZOUM expanding and encrusting; cell divisions very long, more or less irregularly hexangular, border of the septa not as acute as in *C. plumosum.* I have provisionally separated this from the two species above, until we are able to procure more perfect specimens. Named from its resemblance to *Saganella*, Hall.

Geological position and locality: Lower beds of the St. Louis group; Warsaw, Illinois.

COSCINIUM TUBERCULATUM, Prout.

Pl. 22, fig. 6.

Coscinium tuberculatum, PROUT, 1860. Proceed. St. Louis Acad. Sci., vol. 1, p. 573.

POLYZOUM an expansion somewhat concave and broadly recurved toward one margin; tuberculations more or less irregularly arranged in lines, with rythmical dimples marking their summits; those towards the upper border are not dimpled, and are still covered with chalices. Dimples oblong-oval; in a space of twenty m m there are three to four in perpendicular, and four in oblique lines. The mammillation is more crowded towards the upper border, than near the central and lower part of the expansion. I was at first disposed to regard this as an irregular form of the *C. Keyserlingi*, but the arrangement of the dimples on the summits of the mammillæ, and the existence of mammillary swellings instead of an irregularly waved surface, will, it is believed, sufficiently distinguish them from one another.

Geological position and locality: Keokuk group; Warsaw, Illinois.

COSCINIUM ASTERIA, Prout.

Pl. 22, fig. 7, 7*a*.

Coscinium asteria, PROUT, 1860. Proceed. St. Louis Acad. of Science, vol. i, p. 574.

POLYZOUM a thin, irregular encrusting expansion, covered with small chalices, except at certain points, which have the appearance of oblong, radiating or substellar markings formed of more prominent lines of chalices, with narrow abortive spaces between them. These substellar dimples are more or less irregular in form, the rays being sometimes unduly prolonged, but are somewhat regularly arranged in relation to one another, being more or less quincuncial in their distribution. The distance between the substellar points is in general about 5 m. m.

Geological position and locality: Keokuk group, Warsaw, Illinois.

COSCINIUM ESCHARENSE, Prout.

Pl. 22, fig. 8, 8*a*.

Coscinium escharense, PROUT, 1860. Proceed. St. Louis Acad. Science, vol. i, p. 574.

POLYZOUM a flat expansion, most probably encrusting, covered with small chalices except at rythmical points, where the very shallow dimples seem to have denuded the surface. These scars are somewhat irregular in form and distribution, but are mostly oblong-oval in shape. This is no doubt a beautiful species, but the specimen from which the description is drawn is too small and imperfect to give a full view of all its characters.

Geological position and locality: Keokuk group, Warsaw, Illinois.

GENUS CYCLOPORA, Prout.

Cyclopora, PROUT, 1860. Preceedings of St. Louis Academy of Science, vol. i, p. 574.

POLYZOUM discoidal, frondescent, or irregularly incrusting; plates sometimes superposed, with subprismatic chalices longer than broad, having their sides formed of a minutely porous interstitial net-work, developed from a sole marked by transverse bands or wrinkles more or less concentric, sometimes intercurrent or contorted, which are crossed at right angles by delicate, slightly interrupted lines, separating the bases of the chalices and radiating to an actual or imaginary centre almost as regularly as the hymenium of a mushroom or the plates of a *Fungia*, without being, like these, entire in their vertical expansion; chalice apertures on one or both faces shallow and expanded, with interstitial spaces porous and net-like.

We have been induced, from the considerations which follow, to separate this genus from the *Ceriopora* of Goldfuss. This genus, as defined by its author, was rendered too comprehensive, and embraced within its limits too large an assemblage of heterogeneous forms. Many of these have been transferred by subsequent writers to other genera; and M. deOrbigny has more recently excluded from its limits all expansive or incrusting forms, restricting it to such as are ramose, having one or more layers of cells superimposed upon one another, which includes in part the *Inversaria* of Hagenow. We do not feel disposed to admit this mere modification in the growth of the polyzoum, taken separately and alone, as an adequate basis for generic distinction; for it is well known that the superposition of layer upon layer may be the result of age, and we have observed several times, in our investigations, that the expanding and incrusting forms may gradually assume the ramose or convolute modes of growth. On reflection, it will be readily perceived how these accidental modifications of form may be developed, for the approximating borders of an expansion may fail to meet each other in exact apposition, and the convolute form be induced, or an excess of development at certain points on the surface or the margin of the polyzoum may give rise to the ramose forms; or if this latter should be arrested, to a simple tuberculation of the surface.

It will be readily inferred, from these observations, how much difficulty attends the correct classification of this order of the animal kingdom, in which the generic and specific characters are so extremely limited. If we leave out of consideration external forms, which are so invariable and definite in the higher orders of animal life, and search into the minute anatomical elements of their organization, we scarcely feel more secure in our distinctive determinations; for when these are profoundly investigated and viewed in all their relations, they seem but modifications, gradually taking their origin in a common type, as with the Anthozoa, modified as it is into all the beautiful and diversified forms which it presents. We are enabled to ground our groupings into families and genera only on developments, when not accidental, which result from the plastic calcareous or corneous secretions and the form and general arrangement of the cells or chalices; while for specific distinctions we are restricted to narrower limits, or to details of minor importance, such as the relative size and form of the cells, their number and distance apart, and sometimes to phenomena of a purely negative character.

These principles, when more accurately defined, and limited to their proper sphere, may lead to a more correct classification or a more natural arrangement of the Polyzoa than those which have been previously proposed. It must be admitted that the present classification is almost as defective in Polyzoology as when the profound and gifted mind of de Orbigny essayed to establish order where the wildest confusion had previously prevailed. In all deference to his genius and his labors, which are worthy of all praise, we are compelled to believe that he has given too great an expansion to many parts of his system by the multiplication of genera in the different groups, and has sometimes associated forms which have no generic affinities, from losing sight of the terms or the characters on which his distinctions were founded. Those who fully comprehend the difficulties of a correct classification of these often minutely developed forms of living beings, will regard with proper indulgence these errors in an attempt to restore order where nothing but the most indiscriminate complexity had formerly existed. In attempting to make our descriptions conform to a strictly natural system, we are not certain that we shall meet with greater success. All that we can promise is to adhere strictly to this basis of classification, having full faith that principles grounded in nature, fully comprehended and properly interpreted, cannot very far mislead the earnest and humble inquirer after truth. We hope, by our labors, to remove some of the difficulties which oppose themselves to a better understanding of the zoological and palæontological value of this beautiful and interesting, but hitherto much neglected order of fossil forms.

The genus established above is one which embraces several discoidal and incrusting forms. The concentric, more or less banded basis or sole which from its thickening into folds or ridges, gives more strength and firmness to the net-work in which the tiny workers above were implanted, sufficiently distinguishes it from the *Semicoscinium*, with its more or less lamellar and condensed intercellular spaces, and its sole condensed in parallel ridges; from *Coscinium*, with its raised chalice lips, and its sole formed of approximating and receding ridges; or from *Chætetes*, with its more condensed intercellular spaces and its longer tubes, which take their origin in an uncondensed cellular or cancellous structure. The basis of its separation from its congeners of the same group is founded mainly upon the form and character of its sole. This banded arrangement of the condensed base seems to be represented in *Ceriopora verrucosa*, Gold., tab. x, fig. 6*c*, which most probably belongs to this genus. Now, it may be said that where the general characters and the arrangement of the chalices are nearly the same, the distinctions in the form of the sole possess little or no generic value; but this objection can have but little force, unless it can be proved that these differences in the character of the basal plates, and the direction and distribution of the chalices which impressed these forms upon them, were accidental, and not strictly the result of differences in the laws which regulate the definite development of organic forms.

CYCLOPORA FUNGIA, Prout.

Pl. 22, fig. 9, 9 *a*, 9 *b*.

Cyclopora fungia, PROUT, 1860. Proceed. St. Louis Acad. Sci., vol. 1, p. 577.

POLYZOUM a flattened disc, about two inches in diameter, with a central depression on the lower surface, and a somewhat irregular margin; striæ or sole-lines radiating from the centre, somewhat whorled at first, delicate, interrupted or jagged, being *apparently* formed of long, slightly waved, septate, flattened tubes, in juxtaposition on a common plane of expansion; concentric rings more or less rugosely plicated, and marked by depressions, which seem to have resulted from abortive cells larger than those which formed the radiating striæ. As the annulations become more prominent toward the border, the striations become less distinct and more irregular.

Chalices only seen upon the upper face by grinding the lower surface, where they appear to be round or subprismatic, longer than broad, vertical in direction, alternately juxtaposed in radiating lines, with no sheaths distinct from the plexiform interchalicular spaces, which are formed by the union of minute cells, varying in size and development.

A careless observer might refer this species to the genus *Fungia*, as in general appearance it resembles very closely some of the discoidal forms of this coral, more particularly the *Fungia discoidea*, Gold., tab. xiv, fig. 9 *a*. But a minute examination of its structure renders it manifest that it is a true polyzoan, allied somewhat to *Ceriopora* (Gold.) The chalices and the interchalicular spaces are not septate, for we have found on careful examination that the septa in the forms submitted to examination are more imaginary than real, being caused by the breaking in of cells forming a part of the net-like interchalicular spaces.

Geological position and locality: Keokuk group, St. Francisville, Mo.

CYCLOPORA DISCOIDEA, Prout.

Pl. 22, fig. 10.

Cyclopora discoidea, PROUT, 1860. Proceed. St. Louis Acad. Sci., vol. 1, p. 578.

POLYZOUM a flattened subconcave or subconvex expansion, with a central elevation; discoidal portion about two or two and a half inches wide, with radiations distinctly marked, showing the bases of the chalices on the upper surface in connected lines and alternate series. Margin irregular, running into irregular frondescent expansions, which still preserve the concentric form of the banded sole. One specimen is so deeply concave as to become infundibuliform; chalices only on one side, larger and not so long as in *C. fungia*.

Geological position and locality: Keokuk group, Warsaw, Illinois.

CYCLOPORA POLYMORPHA, Prout.

Pl. 21, fig. 5, 5 *a*, 5 *b*.

Cyclopora polymorpha, PROUT, 1860. Proceed. St. Louis Acad. Sci., vol. 1, p. 578.

POLYZOUM a large incrusting expansion, with the ridges variously contorted without the appearance of a disc, although it seems to have had several centres of development. Chalices larger than in the two former species, with the interchalicular spaces more rugose; chalices on both faces, with evidences here and there of a disposition in the layers to superposition. The specimen from which this description is drawn is about four inches broad by as many long, and the whole expansion of the polyzoum seems to have been several times as broad as the space comprehended by these measurements. It is, we think, evidently specifically different from the two preceding forms.

Geological position and locality: Chester group, Pope county, Illinois.

GENUS POLYPORA, McCoy, 1844.

(Carb. Foss. Ireland, p. 206.)

POLYPORA HALLIANA, Prout.

Pl. 21, fig. 4, 4*a*, 4*b*.

Polypora Halliana, PROUT, 1860. Proceed. St. Louis Acad. Sci., vol. i, p. 580.

POLYZOUM a broad fan-shaped expansion, with apparently entire rigid longitudinal rays radiating from a central point, with fenestrules obvious to the naked eye. Longitudinal rays regular, on a plane of expansion only slightly waved without folds or plications, round, straight, or direct, bifurcating nearly oppositely near the base, about two lines near the middle, about four and not so frequently towards the border. Dissepiments mostly alternate, small, depressed, often not much more than connecting points between the longitudinal rays; about one-fourth as long as the fenestrules, and somewhat expanded at their junction with the longitudinal rays. Owing to their depression the spaces between the rays appear as long furrows, somewhat notched. Fenestrules long, oval and narrow, being from twice to three times as long as broad. Two longitudinally in a space of two lines, three transversely. Chalices small, pore-like, juxtaposed in sinistral, spiral lines upon the longitudinal rays; about four lines of alternate chalices, and sometimes five, rarely three towards the base. In straight lines there are about four to each fenestrule, in zigzag eight to nine.

Comparisons.—Resembles *P. Mexicana*, but differs by the want of contraction and expansion above and below the bifurcations, in the fewer number of chalices upon the borders of the fenestrules, and in the general form of the polyzoum.

Geological position and locality: Base of the St. Louis group; Warsaw, Ill.

POLYPORA GRACILIS, Prout.

Pl. 21, fig. 1, 1 *a*.

Polypora gracilis, PROUT, 1860. Proceed. St. Louis Acad. Sci., vol. i, p. 580.

POLYZOUM a long, narrow net-work, proceeding from a pedicle with longitudinal rays of nearly uniform size, appearing to branch much more frequently towards the margins than near the base. Longitudinal rays round, dilating very slightly at the bifurcations; spaces between the bifurcations long, lanceolate, dichotomizations from two to five lines apart, but on parallel rays nearly opposite. Dissepiments very small, expanded at their junction with the longitudinal rays, dividing them into a somewhat irregular net-work. Fenestrules long, oval, but sometimes quadrangular, about as broad as the large, longitudinal rays. Chalices in lines alternately distributed with calcareous raised lips when perfect, common to the chalice openings, which are sometimes depressed at certain points, or elevated by the expansion of the cells forming the substance of the longitudinal rays; four to five lines of chalices on each ray, mostly dextral; about fifteen to twenty to each oscule, with no interjacent lines of very minute pores between them; when the longitudinal rays are worn they appear minutely tubular striate. Reverse long, tuberculate, anfractious, with occasional small pores.

Comparisons.—This very large and graceful species of *Polypora* is allied somewhat, in character, to the *Retepora laxa*, Phillips (*Polypora*, McCoy; *Gorgonia ripisteria*, Goldfuss, vii, fig. 2), but differs from it in being much larger, in branching more regularly, in having no interjacent lines of pores between the chalices, and in the long, ovate form of its oscules.

Geological position and locality: Keokuk group; Warsaw, Illinois.

POLYPORA HAMILTONENSIS, Prout.

Pl. 21, fig. 6, 6 *a*.

Polypora Hamiltonensis, PROUT. MS.

POLYZOUM depressed infundibuliform, or nearly flattened; rays bifurcating rather regularly, rounded and apparently smooth below; dissepiments short, expanding at their connection with the rays, which they nearly or quite equal in size, scarcely more impressed than the rays, with which they also agree in being rounded and nearly smooth on the under, or non-poriferous side. Fenestrules oval, or oval-subcircular, alternately arranged. Cell pores small, arranged in oblique rows varying from three to four in each oblique range across the rays, generally about four to each longitudinal row opposite each fenestrule. Entire size unknown; fenestrules usually six or seven in 0.20 inch, measuring longitudinally parallel to the rays; and about eight in the same space, counting them in the oblique, transverse rows.

Geological position and locality: New Buffalo, Iowa, where it is common on slabs, with one or more species of *Fenestella*, Crinoid columns, etc. Hamilton group, of the Devonian series. Also, less abundantly, in same position at Rock Island, Illinois.

PALÆONTOLOGY OF ILLINOIS.

SECTION III.

REPORT ON THE FOSSIL PLANTS OF ILLINOIS.

By LEO LESQUEREUX.

FOSSIL PLANTS.

AN ENUMERATION OF THE FOSSIL PLANTS FOUND IN THE COAL MEASURES OF ILLINOIS, WITH DESCRIPTIONS OF THE NEW SPECIES.

FIRST DIVISION.—FERN LEAVES.

Genus NEUROPTERIS, Brgt. Frond pinnately or bitripinnately divided; pinnules or leaflets cordate at the base, or nearly so, rarely narrowed; entire or cut-toothed, lanceolate, broadly oval, round, kidney-shaped, etc., joined to the rachis by the middle or the base of the medial nerve, which is sometimes elongated into a short pedicel. Nerves oblique arched, either branching from a medial nerve, which disappears in ascending, or flabellate and dichotomous from the base. This definition unites both genera, *Neuropteris* and *Nephropteris*, Brgt.

Neuropteris hirsuta, Lsqx. *Geol. Rep. of Penn.*, p. 857, tab. 3, fig. 6, and tab. 4, fig. 1 to 16. This is a very polymorphous species. Pl. 35, fig. 8, 9 and 10 of this report, represent large leaflets, placed around the stem of this species at the point of attachment of a primary or secondary pinna. Such leaflets were formerly separated and placed in the genus *Nephropteris* or *Cyclopteris*, Brgt. Fig. 6, of the same plate, is one of the smallest leaflets of this species. Fig. 7 shows a peculiar and abnormal division of a terminal leaflet of the same. Found in the whole thickness and over the whole extent of the Coal Measures, especially in connection with coal No. 1 B. Abounds at Murphysboro, Jackson county, Illinois.

Neuropteris Clarksoni, Lsqx. *Geol. Rep. of Penn.*, p. 857, tab. 6, fig. 1–4. A small specimen from Mazon creek, Grundy county, Illinois; found by Mr. J. Even.* Coal No. 3.

Neuropteris flexuosa, Brgt. *Hist. des Veg. Foss.*, 1, p. 239, tab. 65, fig. 2 and 3, and tab. 68, fig. 2. Abounds at Murphysboro. It follows the same distribution as the former.

Neuropteris rotundifolia, Brgt. *Hist. des. Veg. Foss.*, 1, p. 238, tab. 70, fig. 1. Found at Grayville, White county, Ill. It is perhaps a variety of the former. Upper Coal Measures.

Neuropteris plicata, Sternb. *Vers.*, 2, p. 74, tab. 19, fig. 1–3. Locality: Mazon creek, Grundy county, Illinois. Coal No. 3.

Neuropteris Loschii, Brgt. *Hist. des Veg. Foss.*, 1, p. 242, tab. 73. Locality: Mazon creek. Same position as last.

Neuropteris vermicularis, Lsqx. *Geol. Rep. of Ky.*, vol. 4, p. 434, (pl. 2, fig. 7, ined.) Locality: Mazon creek. Same position.

Neuropteris tenuifolia, Brgt. *Hist. des Veg. Foss.*, 1, p. 241, tab. 72, fig. 3. There is in the State Cabinet at Springfield, a specimen of this species, marked Grayville, and another from Colchester. Upper Coal Measures.

Neuropteris rarinervis, Bunb. Pl. 33, fig. 1 to 5, and Pl. 34, fig. 1 and 1 *a*. This species has a tripinnate or polypinnate frond; secondary pinnæ alternate, long, linear or linear-lanceolate; pinnules alternate, contiguous or distant, oblong, obtuse, cordate and somewhat dilated at the base, with the exterior lobe a little extended, a little undulate on the margin; terminal pinnule deltoid, nearly trilobate; superior pinnæ simple, linear-lanceolate, pinnatifid or with slightly undulate margins; medial nerve distinct, strong near the base; veins distinct, flat, thick, bifurcate.

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* To prevent the necessity of numerous repetitions, I will state once for all, that all the specimens indicated from Mazon creek, Grundy county, were communicated by Mr. Joseph Even, and found in iron-stone concretions.

Our species is evidently the same as that published by Mr. Bunbury from the coal fields of Nova Scotia, though his figure represents the nervation somewhat differently from what it is on our specimens. The number of veinlets along each border of the leaflets varies according to their size. They are equidistant, and not separated in fascicles, as shown by Mr. Bunbury's figure. In the fig. 1 of our plate 34, the veinlets are so close, and the medial nerve so strong, that the species looks more like a *Pecopteris* than a *Neuropteris*. The veins and veinlets of this *Neuropteris*, seen through a glass, appear broad, flattened, or rather divided into two in their whole length, their borders being inflated on both sides, and the middle depressed, as seen in the enlarged part, pl. 33, fig. 4 *a*, and pl. 34, fig. 1 *a*. This peculiar conformation of the veins shows the identity of the large leaves (pl. 33, fig. 3, 4, 5) with this species.* It is common enough in our Coal Measures. I have found it in Pennsylvania, Kentucky and Illinois, generally in connection with coal No. 3. The fine specimens figured pl. 33, fig. 1 and 4, come from Murphysboro, and were presented to me by Mr. James Sampson, of New Harmony, Indiana. A number of specimens in the State Cabinet at Springfield have been found at the same place, and also at DuQuoin. Lower Coal Measures.

Neuropteris Villiersii, Brgt. *Hist. des Veg. Foss.*, pl. 1, p. 233, tab. 64, fig. 1. A very rare species, found only in small specimens. Locality: Murphysboro, Jackson county. Same position as last.

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* I have lately received from Newport, R. I., a specimen of this species, with a round leaf (*Cyclopteris*) attached to the base of a branch, bearing small lanceolate, oblong leaflets (*Neuropteris*), a conclusive proof of the identity of both forms.

Neuropteris heterophylla, Brgt. *Hist. des Veg. Foss.*, 1, p. 243, tab. 71 and 72, fig. 2. This species is abundant in the Anthracite basin of Pennsylvania, in the shales of coal No. 3 and 4, but apparently rare westward. The State Cabinet has a single small specimen on sandstone, from Drury's Landing, Rock Island county, Illinois. Lower Coal Measures.

Neuropteris Desori, Lsqx. *Geol. Report Penn.*, p. 859, tab. 5, fig. 11 and 12, and tab. 20, fig. 5 to 8. Locality: Mazon creek. A very small specimen, referable with doubt to this species. Coal No. 3.

Neuropteris fimbriata, Lsqx. *Geol. Report Penn.*, p. 855, pl. 4, fig. 17 and 18. The specimen of this species (No. 351 of the State Cabinet) was found by myself at Murphysboro, Illinois. It is more like a true *Neuropteris* than any other specimen of this fine species. The fringe of the leaflets is shorter and comes nearer that of *Neuropteris dentata*, Lsqx., with which it may be identical. Lower Coal Measures.

Neuropteris Evenii, Sp. nov. Pl. 36, fig. 4. Frond pinnately divided into alternate, distant, ovate, cordate, obtuse leaflets, attached to the main flexuous rachis by a short pedicel. Veins thin, distant, forking twice, either flabellate from the base or emerging from a short, thin, scarcely noticeable medial nerve. By the general outline of the leaflets, this beautiful species has some likeness with *Neuropteris crenulata*, Brgt., but the margins of our species are evidently entire, and the veins much thinner, though the derm appears pretty thick. The round, smooth, flexuous rachis looks as if this species had been a climbing one. Found at Mazon creek by Mr. Joseph Even, who has greatly enriched the fossil flora of Illinois by his researches, and to whom the species is dedicated.

Neuropteris pachyderma, Sp. nov. Pl. 36, fig, 5. Frond pinnately divided; divisions distant, opposite, sessile, ovate, somewhat pointed, cordate at the base, thick, convex, with a narrow, flattened or recurved margin; nervation obsolete; veins distant and apparently forking once only. The scarcely visible veins are more distant than in the former species. The surface of the leaves is traversed crosswise by irregular wrinkles or fissures through the thick epidermis. The convex, narrowly-margined or flattened leaflets look as if their under surface was thickly covered with spores, though no trace of them can be seen marked by compression upon the upper surface. Locality: Mazon creek. Coal No. 3.

Neuropteris inflata, Sp. nov. Pl. 37, fig. 2. Apparently bipinnately divided. Leaflets large, nearly round or broad oval, rounded at the base, lanceolate above, attached to the rachis by a broad base, inflated or convex on the upper surface. Nerves flabellate, dichotomous or forking in ascending, arched, distinct, thin, resembling those of *Neuropteris hirsuta*, but better marked and inflated near the base. The specimen figured is also from Mazon creek. It shows two opposite leaflets attached to a narrow, irregularly striated rachis, which is apparently connected with a broader main stem, about half an inch thick. Another specimen from the same locality represents the upper part of a pinna, with a number of leaflets, each attached to the rachis by a broad base and diversely folded and superposed. On one side of the branches the leaves are round, like those of our figure, while on the other they are longer, oval-lanceolate, somewhat pointed, resembling the large form of *Neuropteris hirsuta*, but shorter and with a convex surface. From these specimens, and also from two fine ones preserved in the Cabinet of Princeton College, New Jersey, the upper surface of this species appears always convex or inflated.

Neuropteris verbenæfolia, Sp. nov. Pl. 37, fig. 1. This remarkable species is known only by a single specimen from Mazon creek. It is a single leaflet, oval-lanceolate in outline, obtuse at the top, taper-pointed towards the apparently petioled base. The margin is regularly and deeply serrate. The veins pinnately branching from a thin medial nerve, are thin, distant, oblique, arched, forking once only above the middle, each branch ascending to the point of one of the teeth of the leaf. This species has no relation with any other species of our Coal Measures, except perhaps with *Neuropteris fissa*, Lsqx. (*Geol. Report of Penn.*, p. 857), which it resembles only by the distant veinlets, and the large size of the leaves.

Genus ODONTOPTERIS, Brgt. Frond bi or tripinnately branching; pinnules variable, attached to the rachis by the entire, sometimes decurrent or enlarged base; medial nerve slightly or not at all marked; nervules simple or furcate, some of them emerging from the rachis and parallel to each other, some flabellate from the base and dichotomous.

Odontopteris Wortheni, Sp. nov. Pl. 36, fig. 1 and 1 *b*. Frond bipinnatifid. Primary divisions alternate or opposite, ovate, lanceolate, unequally lobed, either entire in the lower part or scarcely divided, with a kidney-shaped leaflet under the point of attachment to the main rachis, or pinnately alternately divided in obovate, obtuse, decurrent divisions, which are generally curved backwards and separated below the middle by an acute sinus; terminal leaflet either cut in two obovate, obtuse divisions, or entire larger, deltoid, obtuse, with short alternate lobes near the base; veins very thin and close, once or twice forked, slightly arched, emerging from a large, flat medial nerve; surface apparently covered with short, straight hairs. Though this beautiful species has some of its large leaflets nearly entire, with arched and dichotomous veins, like those of a *Neuropteris*, it is evidently, by its parallel basilar nervation, a true *Odontopteris*. In the upper part of the frond the pinnæ are deeply, pinnately divided, while the inferior ones are more and more entire, with always a kidney-shaped small leaflet attached to the under side of this base. By these leaflets, and also by its apparently hairy surface, this species has some likeness with *Neuropteris hirsuta;* but it can not be considered as a variety of this polymorphous fossil fern, especially on account of the nervation. This nervation is apparently like that of *Dyctiopteris neuropteroides*, Gutb., in *Geinitz Verst.*, p. 23, tab. 28, fig. 6; and if the short cross lines marked on the surface of the leaves, and resembling short hairs, are divisions of the veinlets, our species would be a new *Dyctiopteris*. But on account of the fineness of the veins, it is impossible to decide if these lines—generally placed in the same direction, but sometimes irregular and even stronger than the veinlets, as marked in our fig. 1*b*—are true hairs or subdivisions of the veins, and thus constitute a peculiar reticulation. Locality: Mazon creek, Grundy county.

Odontopteris heterophylla, Sp. nov. Pl. 38, fig. 2–5. Frond bipinnately and tripinnately irregularly divided; pinnæ lanceolate in outline or cordate ovate; pinnules either entire, oblong or obovate, obtuse, decurrent on the rachis, becoming broader, shorter, cuneiform, even, kidney-shaped at the base of the pinnæ, or elongated, diversely lobed with unequal, long-linear or short, lanceolate, pointed divisions; terminal leaflet large, ovate-deltoid, obtuse, with an obtuse alternate short lobe on each side; veins sharply marked, inflated near the base, generally twice, rarely thrice forking. In the decurrent leaflets the veins are also somewhat decurrent on the rachis, as in fig. 2*a;* in the oval, broad leaflets the veins are obliquely attached to it—fig. 4*a* (somewhat enlarged, like the former). This very variable species is known only from small specimens, found only at Murphysboro. The one of fig. 5 was presented to me by Mr. James Sampson, of New Harmony, Indiana. The others were found by Prof. A. H. Worthen and myself, and belong to the State Cabinet of Illinois.

Odontopteris subcuneata, Bunb. *Quat. Geol. Journ.*, vol. 3, p. 23. It is somewhat doubtful if the branch of *Odontopteris*, figured in our pl. 36, fig. 3, is the same species as that of M. Bunbury. The general form of the leaflets, especially the basilar prolongation into an ear-like appendage, and also the thinness and ramification of the slightly arched and dichotomous veins, are the same. But in Mr. Bunbury's species the leaflets have all the same obovate, obtuse or oblanceolate form and are opposite, while in ours these leaflets vary from short, kidney-shaped, very obtuse, to oblong; lanceolate, acute in outline, and are alternate. The figure of the Nova Scotia species also shows, perhaps by mistake, the veins running into or decurrent upon the main rachis, while in ours they evidently come out from the base of the leaflets. Nevertheless these differences are not marked enough to authorize a specific separation, and we may consider this branch of ours as the inferior part, while Mr. Bunbury's specimen represents an upper part of a frond. By the general outline and the apparent variations of the leaflets, this species is related to the former; but it greatly differs by the thinner, closer and arched veins. Locality: Mazon creek, Grundy county, Illinois. Coal No. 3.

Odontopteris œqualis, Sp. nov. Pl. 36, fig. 2. Nothing is preserved of this peculiar species but the broken part figured here. From this it is not possible to know anything about the primary division of this fossil fern. By its peculiar nervation, and the regularity of the obtuse pinnæ, this species is different from any other of this genus. The pinna was apparently long and linear; its leaflets, separated to below the middle by an acute sinus, either slightly decurrent or perpendicular on the narrow, convex, smooth rachis, are short, about of equal size, rounded at the top; the veins, though thin, are distinct, distant, all parallel at and near the base, oblique or perpendicular, following the direction of the leaflets, and simple or forking once only from above the middle. The thinness of the veins and the general form of the smooth, convex leaflets, separate this species from *Odontopteris Schlothemi*, Brgt. Locality and position: same as last.

Genus SPHENOPTERIS, Brgt. Frond bi or tripolypinnatefid, pinnules generally wedge-form or narrowed at the base, lobed, with the inferior division larger; nervation pinnate, primary veins ascending to the margin, flexuous, secondary veins dichotomous, forking once, twice or thrice in each lobe.

Sphenopteris paupercula, Sp. nov. Pl. 41, fig. 4 and 4 *a.* Frond bipinnatifid; pinnæ linear-lanceolate, apparently long, with a strong rachis; pinnules nearly equal, distant, oblong obtuse, somewhat decurrent by a narrowed base, and oblique on the rachis; margins equally sinuate, or nearly pinnately round lobed; medial nerve flat, broad, pinnately branching in each lobe; veins forking two or three times. Distantly related to *Pecopteris Schœnbeiniana,* Brgt., of the Keuper of Europe. The figured specimen is from St. John, Perry county. I have got a few others from Pennsylvania, but all broken and too small. Coal No. 3.

Sphenopteris irregularis, Sternb. *Vers.,* 2, p. 63, tab. 17, fig. 4. A few specimens of this fine species are preserved in the State Cabinet. Locality: Colchester, McDonough county. Coal No. 3.

Sphenopteris obtusiloba, Brgt. *Hist. des Veg. Foss.,* 1, p. 204, tab. 53, fig. 2. The only specimen of this species in the State Cabinet is poor. It comes from Murphysboro, Jackson county. Lower Coal Measures.

Sphenopteris latifolia, Brgt. *Hist. des Veg. Foss.,* 1, p. 205, tab. 57, fig. 1 to 6. One specimen from Mazon creek shows well the general outline of this species, but the leaflets appear somewhat denticulate by the strong veins projecting beyond the margins and forming points.

Sphenopteris rigida, Brgt. *Hist. des Veg. Foss.,* 1, p. 201, tab. 53, fig. 4. The species figured in our plate 39, fig. 5, 5 *a,* and 6, 6 *a,* is, by its ramification, the form of the leaflets, and the obscure nervation, apparently the same as Brongniart's.

But there is a difference worth mentioning. M. Brongniart says that the leaves are coriaceous and very smooth; while in our specimens the surface is evidently rugose, as if it had been originally squamose or hairy. On a specimen in the Cabinet of Amherst College, the surface of the leaflets appear perfectly smooth and the veins deeply marked, thus agreeing exactly with Brongniart's description. The difference is probably casual, and caused by a more or less prolonged masceration of the plants, before the solidification of the shales. The Illinois specimens are from Colchester (coal No. 3), and the fern has preserved its epidermis transformed into a thin coat of coal. The specimen at Amherst has a naked surface.

Sphenopteris abbreviata, Lsqx. *Geol. Rept. Penna.*, p. 861, tab. 9, fig. 1 and 1*b*. Mazon creek; a small specimen.

Genus HYMENOPHYLLITES, Gopp. Frond membranaceous, many times regularly pinnately divided or irregularly cut, lobed with pinnatifid or dichotomous divisions decurring on a broad common rachis, which is sometimes indistinct; veins pinnate, percurrent, solitary in each division.

Hymenophyllites pinnatifidus, Sp. nov. Pl. 34, fig. 2 and 2*a*. Frond tripinnate; primary pinnæ large, with divisions alternate and open, perpendicular on the smooth round rachis; secondary pinnæ lanceolate, with alternate ovate-lanceolate short pinnules, which are also pinnately parted in ridge-shaped divisions. These are generally cut in two or three lanceolate, obtuse lobes, the terminal one simple and small. The species is related to *Hymenophyllites Hildrethi,* Lsqx., *Geol. Rept. Penn.*, p. 863, tab. 9, fig. 5 and 5*a*, differing from it by the ramification, the shorter and more obtuse lobes, etc., and also (but distantly) to *Sphenopteris lanceolata,* Gutt. Abundant at St. John and Colchester, in the roof shales of coal No. 3.

Hymenophyllites spinosus (*Sphenopteris*), Goppt. *Gattg. Foss.*, pl. 3–4, p. 70, tab. 12. This very fine and rare species is figured pl. 34, fig. 3 and 3*a*. It does not differ from the European species. Only in ours the nervation, till now undescribed, is, though obsolete, distinct enough for examination. The main or medial nerve is formed from a facicle of very thin, filiform, parallel veinlets forking with its division, percurrent or running to the margin, where they still appear double. This nervation renders the base of the leaflets and the common, somewhat winged rachis, inflated or thickened in the middle. It is thus a true *Hymenophyllites*, more properly belonging to the second division (*Pachyphyllum*). This species was found at Colchester. Coal No. 3.

Hymenophyllites alatus, Brgt. Pl. 39, fig. 1.

Sphenopteris alata, Brgt. *Hist. des Veg. Foss.*, 1, p. 180, tab. 48, fig. 1. Our species is apparently identical with that of Europe, but like most of our other species of fossil plants, it has some peculiar characters, which do not perfectly accord with the typical form. The lobes or divisions of the pinnæ are not perpendicular on the rachis, as in M. Brongniart's figure, but oblique and much more approached to each other; and the veins, pretty thick at and near the base, become thinner in ascending and dividing, and are lost or obsolete near the margins. A fruiting specimen, figured by Geinitz, *Verst.*, tab. 24, fig. 15, resembles our American form more than Brongniart's. Locality: Roof shales at Colchester. A good specimen of this species has recently been found at Morris, Grundy county—showing that our species is identical with the European.

Hymenophyllites hirsutus? Lsqx.

Pachyphyllum hirsutum? Lsqx. *Geol. Rept. of Penna.*, p. 863, tab. 8, fig. 3. The specimens are too small for a satisfactory examination. The surface of the stem is hairy, but the lobes or divisions are more obtuse than in the Pennsylvania specimen. Mazon creek, Grundy county. Coal No. 3.

Hymenophyllites Clarkii, Sp. nov. Pl. 39, fig. 7. Frond apparently large, irregularly divided; primary divisions oblique, decurrent, obovate, irregularly subpinnately cut in obtuse, oblanceolate, short, subreflexed lobes; veins fasciculate at the base and along the common inflated rachis, simple in ascending into the secondary or tertiary divisions, or irregularly dichotomous, thin, ascending to the sinuses of each lobe. It is distantly related to *Hymenophyllites Gutbierianus*, Ung. We know it only from small specimens. The first one sent to me was found by Mr. James H. Clark, of Newport, R. I. The one figured here is from Mazon creek, Grundy county, Illinois.

Genus ALETHOPTERIS, Sternb. and Gopp. Frond bitripinnate or tripinnatifid; secondary nerves perpendicular or nearly oblique to the medial nerve, simple, once or twice forking; margins of the pinnules often revolute.

Alethopteris aquilina, Brgt. *Hist. des Veg. Foss.*, 1, p. 248, tab. 90. Our American form does not agree perfectly with the descriptions and figures of the European species. The leaflets are narrower, the margins more reflexed, the nervation less distinct, sometimes obsolete. Locality: St. John, Perry county, Illinois.

Alethopteris Massillonis, Sp. nov. Pl. 40, fig. 1–4. Frond tripinnately divided; primary rachis about one inch thick, irregularly grooved and striated, smooth, with horizontal, alternate branches; pinna diversely divided. In the superior one? the naked rachis bears alternate long, linear, pointed pinnæ, deeply pinnately lobed, with alternate, oval-lanceolate or oblong obtuse pinnules, irregularly undulate on the margins, and separated to near the base, by a broad, flat or acute sinus. In the inferior? primary pinnæ, the narrow rachis is winged, or the shorter secondary pinnae are pinnately divided into regular, proportionally broader pinnules, becoming shorter in ascending, and forming only regular, broad, alternate undulations near the top of the pinnæ—fig. 3. The terminal pinnule is lanceolate, acute, undulate, lobed at the base. Medial nerve broad, ascending to at least three-fourths of the leaflets; nervules oblique, deeply marked, all forking twice.

This species appears distinct from all the others of this genus. It has some relation to the former and also to *Alethopteris Dournardii,* Brgt., especially by its pointed terminal leaflet, but it is different from both by the nervation, the size and the form of this terminal leaflet. As in *Pteris aquilina* of our time, part of the pinnæ, probably the lower ones, have a winged rachis, and the tertiary divisions become insensibly shorter in ascending to the point of the pinna, which is thus only pinnately divided near the top.

The species is abundantly found at Massillon, Ohio, in the shales of No. 1 B coal. I have never seen it elsewhere, except once among the specimens sent by Mr. Even from Mazon creek. Though this last specimen has its nervation somewhat obsolete, it evidently belongs to this species. It is copied fig. 4. A large specimen, showing the common broad rachis and horizontal branches, as described above, is not figured here.

Alethopteris Owenii, Lsqx. *Geol. Rep. of Arkansas,* vol. 2, p. 309, pl. 2, fig. 1 and 1 *a.* A small indistinct fragment from Mazon creek, is referred with doubt to this species.

Alethopteris Serlii, Brgt. *Hist. des Veg. Foss.,* 1, p. 292, tab. 85. Abounds at Murphysboro, Jackson county, Illinois.

Alethopteris crenulata, Gopp.

Pecopteris crenulata, Brgt. *Hist. des Veg. Foss.,* 1, p. 300, tab. 87, fig. 1. This species is extremely rare. M. Brongniart saw and figured only a small branch of it, resembling that of our fig. 4. Though still incomplete, the specimens figured on our plate 39, fig. 2, 3 and 4, evidently show that this species is a true *Alethopteris,* of large size, at least bipinnately, but more probably tripinnately divided, with a punctulate and irregularly striated rachis. In all our specimens the pinnules are ovate, obtuse, regularly divided to near the rachis, separated by a flat sinus, and thus leaving a narrow margin along the tertiary rachis. In the specimens fig 2 and 4, the derm of the leaflets is gone, and the nervation is perfectly distinct. All the veins are oblique on the narrow midrib, arched and forked once. In the large specimen, fig. 3, the derm of the leaflets is preserved, and the indistinct veins appear simple and straight, just as they are figured by M. Brongniart. All our specimens are from Mazon creek, Grundy county. Coal No. 3.

Alethopteris stellata, Sp. nov. Pl. 34, fig. 4 and 4 *a.* Frond pinnate; pinnæ oblique, linear, obtuse or abruptly cut; margins undulate, decurrent along the medial nerve or common rachis; primary and secondary veins pinnately branching; veinlets simple, alternate, oblique, slightly arched, bearing at their extremities, just on the border of the somewhat elevated margin, a round, stellate, six-lobed sporange. I have figured all that can be seen of this remarkable species, which should perhaps be referred to the genus *Asterocarpus,* Gopp. It appears, nevertheless, more nearly related to *Alethopteris cristata,* Gutb., from which it is essentially different by the decurrent margin of the leaflets. The medial primary nerve is strong enough, but the secondary veins are thin, straight, and ascending, without thinning, to the top of the leaflets. Fig. 4 *a* and 4 *b* show the enlarged form of the sporanges as distinctly as it is possible to see it with a glass. Locality and position: same as last.

Genus CALLIPTERIS, Brgt. Frond bi or tripinnatifid; pinnæ long, decurrent on the common rachis; pinnules continuous, oblique, obovate or oblanceolate, united and decurrent at the base; medial nerve thick, oblique or arched; secondary nerves oblique, arched, dichotomous.

Callipteris Sullivantii, Lsqx. Pl. 38, fig. 1, and *Geol. Rep. of Penn.,* p. 866, tab. 5, fig. 13. This fine species was first found at Shamokin, in the Anthracite coal fields of Pennsylvania, in poor and broken specimens. From the numerous specimens found at Colchester, in the roof shales of coal No. 3, the species has been more satisfactorily studied. Frond apparently very large, and at least bipinnate; secondary pinnæ lanceolate, with a broad canaliculate rachis; pinnules alternate, oblique, obovate or oblong, nearly contiguous, slightly decurrent by the base, and united together with a slightly obtuse sinus; medial nerve broad and flat, abruptly disappearing above the middle of the leaflets; veins obliquely arched, slender, close, mostly twice forked.

Genus PECOPTERIS, Brgt. Frond bi or tripinnate, or many times pinnately divided; pinnules ordinarily enlarged, united together or decurrent at the base; veins oblique on the medial well marked nerve, simple or forking; fruit dots round, ordinarily two ranked. The genus *Pecopteris* may be, and has already been, subdivided, but this separation is based on such variable or indistinct characters (the fructification) that it is scarcely possible to attempt it, or to admit it, with the materials now at hand.

Pecopteris pteroides, Brgt. *Hist. des Veg. Foss.*, 1, p. 329, tab. 99, fig. 1. Specimen in the State Cabinet, from Mazon creek. It is the only one which I have seen from the Coal Measures of America. Coal No. 3.

Pecopteris Cistii, Brgt. *Hist. des Veg. Foss.*, 1, p. 330, tab. 106, fig. 1 and 2. This specimen, also from Mazon creek, has the nervation and the form of the leaflets of *Pecopteris abbreviata*, Brgt., and could be referred to this species, but for the very narrow rachis. It is probably the upper part of a frond of *Pecopteris Cistii.*

Pecopteris polymorpha, Brgt. *Hist. des Veg. Foss.*, 1, p. 331 and 332, tab. 13. (*Pecopteris Miltoni*, Brgt., *Loc. Cit.*) It abounds in fine specimens on the Wabash river, below New Harmony, Indiana, and also at Grayville, Illinois; Upper Coal Measures.

Pecopteris velutina, Lsqx. *Geol. Report Penn.*, p. 866, tab. 12, fig. 3 and 3 *a*. A rare species. The locality of the specimen in the State Cabinet is unknown.

Pecopteris villosa, Brgt. *Hist. des Veg. Foss.*, 1, p. 316, tab. 104, fig. 3. Abounds in the roof shales of coal No. 3, at St. John, Crooked creek, Carlinville, etc.

Pecopteris oreopteredis, Brgt. *Hist. des Veg. Foss.*, 1, p. 317, tab. 104, fig. 2; tab. 105, fig. 1 to 3. Found at Murphysboro and at Mazon creek, Grundy county.

Pecopteris arborescens, Brgt. *Hist. des Veg. Foss.*, 1, p. 310, tab. 101. Locality: Mazon creek, Grundy county. Rare in Illinois.

Pecopteris lepidorrhachis, Brgt. *Hist. des Veg. Foss.*, 1, p. 313, tab. 103, fig. 1 to 5. Our species is exactly conformable with the description and figures of M. Brongniart. The rachis is squamose, the leaflets sometimes a little broader. It is evidently distinct from the former species. Locality: Mazon creek, Grundy county. Coal No. 3.

Pecopteris unita, Brgt. *Hist. des Veg. Foss.*, 1, p. 342, tab. 116, fig. 1 to 5. Abundant at Duquoin, Colchester, Mazon creek, etc.

Pecopteris plumosa, Brgt. *Hist. des Veg. Foss.*, 1, p. 348, tab. 121 and 122, and *Pecopteris acuta*, Brgt., *Loc. Cit.*, 1, p. 350, tab. 119. Same distribution as the former species.

Pecopteris nervosa, Brgt. *Hist. des Veg. Foss.*, 1, p. 297, tab. 94. The State Cabinet has only a small specimen from Murphysboro, Jackson county. Lower Coal Measures.

Pecopteris callosa, Sp. nov. Pl. 35, fig. 1 to 5. Frond bi or tripinnatifid. Pinnæ linear-lanceolate, obtuse, with a broad unequally lobed, deltoid-terminal leaflet; pinnules oblong or ovate-lanceolate, or broadly oval, narrowed at the base, and somewhat decurrent on the winged rachis, distinct, sometimes distant, with more or less undulated or pinnately round-lobed margins; medial nerve flat and smooth. The epidermis of the leaflets is thick, smooth, and the veinlets obsolete—appear generally as marked fig. 1 *a*. Fig. 2 *a* represents the only leaflet where I could distinctly see the veins. They are pinnately branching from the medial nerve, arched oblique, forking once below the middle. Found at Murphysboro, in small specimens. Lower Coal Measures.

Pecopteris Newberryi, Lsqx. *Sphenopteris Newberryi*, Lsqx., *Geol. Report of Penn.*, p. 862, tab. 9, fig. 4. Locality: Mazon creek. Small specimen. Coal No. 3.

Pecopteris Murrayana? Brgt. *Hist. des Veg. Foss.*, 1, p. 358, tab. 26, fig. 1 to 5. A small specimen from Mazon creek, and a large one from Newport, R. I., have all the characters of this species of the Oolite of Europe. M. Brongniart already remarks, in his examination of this species, that one species apparently identical with it is found in the Coal Measures of France. A small specimen also from Mazon creek, is referable by the form of the leaflets to *Pecopteris chærophylloides*, Brgt., *Hist. des Veg. Foss.*, 1, p. 357, tab. 125, fig. 1 and 2, but the nervation is indistinct.

SECOND DIVISION.—LEAVES OF UNCERTAIN OR UNKNOWN AFFINITIES.

Genus CORDAITES, Ung. Stem erect, ringed by the persistent base of the leaves; leaves simple, half embracing the stem, long, linear, sometimes obovate, one to two inches broad; veins thin, parallel, equal or rarely forking.

Cordaites borassifolia, Ung. Abounds in the roof shales of the coal strata, presenting various forms which probably belong to different species. The long, narrow, entire leaves resemble those of some Palms. Some of the numerous rootlets found in the Coal Measures have been referred to this genus by hypothetical induction. Locality: Murphysboro, St. John's, etc Lower Coal Measures.

Genus SPHENOPHYLLUM, Brgt. Stems articulate, branching from the articulations; leaves verticillate by six to twelve, wedge-shaped, truncate at the top, either bilobate, or dentate, or furcate; nerves ascending from the base, equal, forking.

Sphenophyllum Schlotheimii, Brgt. *Prod.*, p. 68, is not rare at Colchester and Duquoin. Coal No. 3.

Sphenophyllum emarginatum, Brgt. *Prod.*, p. 61. Generally found with the last.

Genus ANNULARIA, Sternb. Stems slender, articulate, branching from under the base of the leaves; leaves verticillate around the articulations, united at the base, entire, generally obtuse, oblanceolate, single nerved, of unequal length.

Annularia longifolia, Brgt. *Prod.*, p. 156. Especially found in connection with coal No. 3 and 4. Mazon creek, Grundy county, Illinois.

Annularia Sphenophylloides, Ung. Is found with the former, also at Murphysboro, Jackson county.

Genus ASTEROPHYLLITES. Stems articulate, with opposite branches, and leaves at the articulations; leaves numerous, verticillate, slightly united at the base, of equal length and size, linear acute, marked with a medial nerve. Inflorescence from ear-like receptacles at the end of the branches or sessile on the stems, apparently diœcious.

Asterophyllites longifolius? Brgt. *Prod.*, p. 159. Leaves subulate, about three inches long, straight. The specimen in the State Cabinet is from Mazon creek, Grundy county, and indistinct. It may belong to *Asterophyllites rigida*, Brgt. Coal No. 3.

Asterophyllites equisetiformis, Brgt. *Prod.*, p. 159. Locality: Duquoin, Perry county. Coal No. 3.

Asterophyllites sublævis, Lsqx. *Geol. Rept. of Penna.*, p. 851, tab. 1, fig. 3. A few small specimens from Mazon creek.

Asterophyllties lanceolatus, Lsqx. *Geol. Rept. of Penna.*, p. 852. Mazon creek, Grundy county. Coal No. 3.

THIRD DIVISION.—STEMS OF UNCERTAIN OR UNKNOWN AFFINITIES.

Genus CALAMITES, Suck. Stems cylindrical, hollow, articulated, striated lengthwise; furrows or striæ either alternating or converging at the articulations; leaves whorled, encircling the stem at the articulations like an open sheath; ramification regular or irregular from the articulations; elevated scars or tubercles marked above or below the point of attachment of the leaves.

Calamites Suckowii, Brgt. *Hist. des Veg. Foss.*, 1, p. 124, tab. 15, fig. 1–6. Variable, and found at various situations. Carmi, Wabash river. Locality: Upper Coal Measures.

Calamites ramosus, Brgt. *Hist. des Veg. Foss.*, 1, p. 127, tab. 17, fig. 5 and 6. Locality: Duquoin and Murphysboro.

Calamites cruciatus, Sternb. *Vers.*, 1–4, p. 27, tab. 49, fig. 5. Found at Duquoin.

Calamites cistii, Brgt. *Hist. des Veg. Foss.*, 1, p. 129, tab. 20. Some specimens of the State Cabinet are from Grayville; some have no marked locality.

Calamites pachyderma, Brgt. *Hist. des Veg. Foss.*, 1, p. 132, tab. 22. There is in the State Cabinet a single specimen, without marked locality. This species is always found within or below the Millstone-grit or Conglomerate formation.

Calamites bistriatus, Lsqx. *Geol. Rept. of Penna.*, p. 850, tab. 2, fig. 1. A specimen in the State Cabinet. Locality unknown.

Calamites approximatus, Brgt. *Hist. des Veg Foss.*, 1, p. 134, tab. 24, fig. 7 and 8. Not rare in Illinois. Carmi, Springfield, Duquoin, etc. Upper Coal Measures.

Genus ARTISIA, Sternb. Woody cylinders, apparently a central pith, narrowly transversely ribbed, referred to *Lomatofloyos*, Sternb., by Corda, to *Conifers* by some authors, and to *Calamites* by some others.

Artisia transversa, Sternb. Specimens in the State Cabinet from Grayville, Upper Coal Measures. I have in my possession some of these woody cylinders, about two inches in diameter, somewhat compressed, exhibiting transversal ribs on one side and longitudinal striæ, just like those of *Calamites*, on the other.

FOURTH DIVISION.—BRANCHES, STEMS AND FRUITS OF LYCOPODIACEA.

Genus SELAGINITES, Brgt. Stems dichotomous; leaves small, numerous, imbricated, sometimes enlarged at the base, scarcely leaving any visible scars.

Selaginites uncinnatus, Sp. nov. Pl. 41, fig. 3. The only specimen seen of this species is in the State Cabinet. I found it at Colchester, on a broken slab of roof shale, where nothing more can be seen but what I have figured. It evidently represents a plant of the *Lycopodiaceæ*, with a slender, irregular forking stem, covered with short, acicular, numerous leaves, mostly perpendicular to the stem, apparently not enlarged at the base. On the branches the leaves appear shorter, more erect and imbricated. The small and latest branches, in their unfolding, have the same spiral disposition as some *Lycopodiaceæ* and the Ferns. This species is distantly related to *Selaginites Erdmanni*, Germ. Coal No. 3.

Selaginites cavifolius, Lsqx. *Lycopodites cavifolius*, Lsqx. *Geol. Rept. of Ky.*, vol. 4, p. 437, tab. 4, fig. 4 and 4*a*, ined. Small specimens from Colchester. Coal No. 3.

Selaginites crassus, Sp. nov. Pl. 39, fig. 8. Stem thick, apparently creeping, dichotomous, with short, thick branches, covered with densely imbricated oval, concave, somewhat pointed leaves. It differs from the former by the shorter, less concave leaves and short branches. Mazon creek; a small specimen. Same position as last.

Genus LYCOPODITES, Brgt. Branches pinnately divided and continuous; leaves either placed all around the stem or distichous, in opposite series, scarcely leaving distinct cicatrices.

Lycopodites asterophyllitæfolius, Sp. nov. Pl. 37, fig. 3. The two branches figured are apparently from the same stem. The long, linear, pointed leaves, placed all around the slender branches are generally curved either upward or backward, sometimes reflexed from the middle, apparently marked by a medial nerve, thus resembling the leaves of *Asterophyllites*. The scars left on the branches are only irregular points, without any trace of a peculiar form. The leaves are apparently sessile by their whole not enlarged base; the medial nerve is scarcely marked. These branches could be considered as belonging to some primeval species of coniferous trees, rather than to *Lycopodiaceæ*. The communication of this remarkable species is due to Mr. Joseph Even, who found it in an iron nodule at Mazon creek. Position same as last.

Genus STIGMARIA, Brgt. Stems creeping or floating, horizontal, two to four inches in diameter, sometimes very long, forking or dichotomous, with a generally eccentric cylindrical pith; bearing around it long, leaf-like, cylindrical appendages, simple or rarely forking, slightly contracted at the base, with a single central vascular fascicle. Scars or bolsters more or less regularly placed in spiral, round, with a double ring, and a single elevated point (*mamilla*) in the middle.

Stigmaria ficoides, Brgt. *Mem. Hist. Nat.*, p. 82 and 88. This species has the characters of the genus. It never theless shows various forms, which have generally been considered as varieties, but which most probably are species. Mentioning a few of them, we have:

var. undulata, Gopp. With the scars separated by undulate ribs.

var. reticulata, Gopp. With a reticulated surface.

var. stellata, Gopp. With the scars surrounded by regular wrinkles, resembling the rays of a star.

The species is generally and abundantly found in the whole thickness of our Coal Measures. Beautiful specimens of the three varieties enumerated above, found in Pope county, under the upper Archimedes limestone, are preserved in the State Cabinet, together with *Stigmaria anabathra,* Corda, *Stigmaria minor,* Gopp., and *Stigmaria umbonata,* Lsqx., which can not be separated from this *Stigmaria ficoides,* unless the other varieties are admitted as true species.

Stigmaria Evenii, Lsqx. Pl. 39, fig. 9. This speces is not comparable to any other form of this genus. It is remarkable, indeed, for the great irregularity of position of the scars, their generally small and at the same time very variable size, sometimes as small as a point. They are then approached by two together, while the largest are isolated. Generally they are separated by short undulate ribs, somewhat like those of *Stigmaria undulata,* Gopp., but less regular and shorter. The central point is obsolete, and sometimes entirely undiscernable. Found at Mazon creek, by Mr. Jos. Even. Coal No. 3.

Genus SIGILLARIA, Brgt. Stem large, tree-like or erect, marked on its surface with parallel ribs or reticulated in different directions, even nearly smooth, impressed with the cicatrices of deciduous leaves, placed around the stems in spiral or quincuncial order; cicatrices disciform, oblong, or round, with mostly angular sides, the upper part emarginate, marked in the middle by scars of vessels, horizontally placed in three, sometimes two, rarely simple.

Some authors have attempted to divide the genus *Sigillaria*, and also the genus *Lepidodendron*, into a number of different genera; but this attempt appears to be a failure, from the great unreliability of the characters considered as specific. Some of our American types might authorize such a division more appropriately than any European species. Nevertheless such divisions can not be proposed in a report where all the necessary materials can not be brought together and examined in detail.

Sigillaria monostigma, Sp. nov. Pl. 42, fig. 1–5. A very fine and remarkable species. In its corticated state, the scars (fig. 1*a* and fig. 3) are broadly rhomboidal, acute at the sides, marked near the obtuse upper angle by a small, round, vascular scar and a central point, resembling, by its general form, that of a *Stigmaria*, but much smaller. The surface between the cicatrices is striated by straight, parallel, narrow lines, running in the direction of the four axes or perpendicular to the four sides of the rhomboidal scar. These scars bear on both sides, from the corners of their acute angles, inwardly curved appendages like those of some species of *Lepidodendron*. In the decorticated state, the striæ of the surface are obliterated and the scars have various forms, changing from rhomboidal to oval, then to arched lines or to round points only, representing the vascular scars, which are generally preserved. The passage from one form to the other can easily be followed on the figures. Fig. 4 represents a specimen apparently deprived of the whole thickness of the bark. It shows the lower side of a thin plate of shale, about one-eighth of an inch thick, which bears upon its upper surface corresponding scars like those of fig. 5. Goldenberg, in the second *Liv.* of his *Flora Sarræpontana*, etc., has recently published a new species—*Sigillaria rimosa*, Gold.—which is somewhat related to our American species. The general form of the scars, even of those of fig. 4, is much alike; but the essential character, viz: the position and the form of the vascular scars is totally different. The surface is also striated in another manner. Our species represents a new type, till now peculiar to America, and far more different from the true *Sigillariæ* than is the genus *Syrigodendron,* Brgt. Locality: Colchester.

Sigillaria sculpta, Lsqx. *Geol. Rept. Penna.,* p. 871, tab. 13, fig. 3. Locality: Duquoin, Perry county.

Sigillaria Menardi, Brgt. *Hist. des Veg. Foss.,* 1, p. 430, tab. 158, fig. 5, 6. The figured specimen of our pl. 43 was found by myself at Colchester, and belongs to the State Cabinet, at Springfield. It shows the scars of the leaves and the broad round cicatrix of a branch. This cicatrix makes of our species a true *Ulodendron,* nearly related, indeed, to *Ulodendron punctatum,* Sternb., while the scars of the leaves show it to be a true *Sigillaria.* I can not see any difference between this species and *Sigillaria Menardi,* Brgt. The outline of the scars, as it is seen from the figure, is very variable, passing from rhomboidal, pointed at both ends, to conical-obtuse, then to enlarged-polygonal, and even to acute-hexagonal. The differences are easily accounted for by a difference of direction of the angles, according to an irregular compression of the sides, following the place occupied by the base of the leaves. The branch scar is broadly oval or nearly round, bordered by a small margin, narrowly and irregularly wrinkled, with a small axis, marked by a deep cavity.

The specimen figured here is of true scientific interest, first, in showing the great variations of the leaf-scars, even on a surface of small extent; secondly, by proving that the genus *Ulodendron,* as it has been established, represents only a peculiar state of some species of *Lepidodendron*—or rather, that some species of the genus *Sigillaria,* belonging to the section of the *Leiodermariæ* (without ribs), are more nearly related to the genus *Lepidodendron* than to the costate *Sigillaria.*

They form an intermediate genus which, difficult to limit as it is now, will become separated when our American species have been more fully collected and studied.

Sigillaria Brardii, Brgt. *Hist. des Veg. Foss.*, 1, p. 431, tab. 158, fig. 4. Colchester and Duquoin.

Sigillaria tessellata, Brgt. *Hist. des Veg. Foss.*, 1, p. 436, tab. 157, fig. 1, and tab. 162, fig. 1–4. Found at Colchester.

Sigillaria intermedia, Brgt. *Hist. des Veg. Foss.*, 1, p. 474, tab. 165, fig. 1. The State Cabinet has two specimens, from Carmi, White county. Upper Coal Measures.

Sigillaria Yardleyi, Lsqx. *Cat. of Foss.*, pl. —, p. 17, tab. 2, fig. 4. Locality: Big Vermilion river.

Sigillaria reniformis, Brgt. *Hist. des Veg. Foss.*, 1, p. 470, tab. 142. A common species. The specimen in the State Cabinet is without indication of locality.

Genus SYRIGODENDRON, Brgt. Stems furrowed; ribs equal, parallel, narrow, convex, bearing on the corticated surface of the ribs, small, round or curved mammillæ, without any vascular scars.

Syrigodendron pachyderma, Brgt. *Hist. des Veg. Foss.*, 1, p. 479, tab. 66, fig, 1. A specimen in the State Cabinet without indication of locality.

Genus LEPIDODENDRON, Sternb. Stems of various size, sometimes very large and long, with a dichotomous ramification or forking in ascending; and bearing linear, grass-like leaves on the young branches; surface of the stem marked by the impressions or cicatrices left at the base of the leaves, or at their point of attachment; cicatrices rhomboidal or oval, acute at both ends, sometimes deltoid, marked in the middle or in the upper part by triangular or rhomboidal vascular scars. These are ordinarily marked in the middle by three points; sometimes they have, descending from both the angular sides, two arched lines, named *appendages*, and just under the scars, near the middle, two oval, slightly diverging impressions, named *tubercles*. The vascular scars are also sometimes overtopped by triangular, trapezoidal or pointed marks, named the *crown*. According to the form of the cicatrices, and the form and position of the scars, this genus has been divided into four sections: *Lepidodendron*, *Sagenaria*, *Aspidaria* and *Bergeria*, considered by some authors as true genera. But as some of our American species belong at the same time to at least two of these divisions, according to their corticated and decorticated appearance, I have not yet found the advantage of preserving any of them for a classification.

Lepidodendron diplotegioides, Lsqx. Pl. 49, fig. 2, and *Geol. Report of Ark.*, tab. 4, fig. 2. Stem apparently of small size; cicatrices rhomboidal, obtuse on both sides, acute at both ends, margin broad and smooth; vascular scars elliptical, enlarged and acute at the sides, arched above, obtuse below, marked in the middle by three oval, close, nearly continuous points; appendages and tubercles none; crown an irregular oval point; medial line scarcely marked by a few deep wrinkles. In the decorticated state the cicatrices are exactly rhomboidal, somewhat inflated, marked in the middle by a straight line, or an elongated, deep point. Our specimen, which I found at Colchester, and which belongs to the State Cabinet, completes the small decorticated specimen from the lower coal of Arkansas, from which the species was established. It proves at the same time that some species of *Lepidodendron* ascend from the coal under the Conglomerate, as high as our coal No. 3.

Lepidodendron Worthenii, Sp. nov. Pl. 44, fig. 4 and 5. Stem slender; cicatrices oblanceolate, narrowed and continuous at the base, transversely much wrinkled, bordered with a narrow, smooth margin. Vascular scars as broad as the cicatrices, acute at both sides, emarginate above, very obtuse, arched in the lower part, marked in the middle by three equal small points, and overtopped by a pointed crown; tubercles none, appendages marginal. A fine species found at Murphysboro, Jackson county. Coal No. 1 B.

Lepidodendron turbinatum, Sp. nov. Pl. 44, fig. 6. Cicatrices very inflated, obovate, obtuse at both ends, rugose near the base, encircled with a high, smooth, obtuse, broad margin; vascular scars obscure, placed at the top of the cicatrices, broad, acute on the sides, slightly emarginate above, very obtuse below, marked with three points, without tubercules or appendages. Locality: Carroll's place, Pope county; Chester group.

Lepidodendron costatum, Sp. nov. Pl. 44, fig. 7. Cicatrices scarcely marked if at all; apparently oval, wrinkled, flat, separated by a rugose half an inch broad, straight contiguous margin, resembling the intermediate ribs of a Sigillaria. Vascular scars deeply and broadly notched above, arched below, angular on the sides, marked in the middle by two large external points, and a smaller medial one; appendages long and well marked; crown a large oval point. A beautiful species, found also at Carroll's place, under the Upper Archimedes limestone. Chester group.

I was at first inclined to consider the three last named species as representing different forms of the same, at different stages of the growth of the plant; but there is too much difference in the form of the cicatrices. Should other specimens of these species support the first supposition, the two last forms may be described as varieties, and the specific name, *Lepidodendron Worthenii*, preserved. It is but just that such a fine species bears the name of Prof. A. H. Worthen, who has done so much for the Palæontology of the West by his indefatigable researches.

Lepidodendron obscurum, Sp. nov. Pl. 44, fig. 1 to 3. Cicatrices flat, rhomboidal, obscurely marked, distant and separated by longitudinal, deep, slightly undulate striæ, becoming more and more marked, and forming deep furrows in the old part of the trees. Vascular scars central, round or oval, irregular, without appendages and tubercles. This species is from Carroll's place, like the former. It is distantly related to *Lepidodendron Carpentieri*, Gopp., and like both the following species belongs to the section of the *Aspidariæ*. Chester group.

Lepidodendron radicans, Sp. nov. Pl. 46, fig. 1. Cicatrices large, irregularly oval, very obtuse on the sides, pointed or somewhat narrowed and continuous at both ends; vascular scars central, generally eccentrical on one side of the cicatrices, obliterated by irregular, deep, large striæ or narrow ribs, apparently the marks of flattened rootlets. The species has some relation with *Caulopteris macrodiscus*, Sternb., but in one specimen the scars are continuous and have the spiral portion of the cicatrices of *Lepidodendron*. I found this specimen at Duquoin. It belongs to the State Cabinet.

Lepidodendron simplex, Sp. nov. Pl. 45, fig. 5. Cicatrices narrowly elliptical, acuminate at both ends, continuous, separated only by narrow, linear margins, entirely naked and smooth; vascular scars central, rhomboidal, very obtuse above, narrowed at the sides and also at the obtuse base; marked by three equal points. No traces of appendages, or tubercles, or crown.

This species is nearly related to *Lepidodendron rimosum*, Sternb., differing essentially by the cicatrices being closely placed, not separated by broad, wrinkled margins, and the scars obtuse (not angular). The leaves of this species are narrow, as seen in the figure, of the same breadth as the leaves of *Lepidodendron rimosum*. I have figured one leaf as it appears attached to the stem; but this appearance might be deceptive. The leaves, fig. 6 and 7, also leaves of another species of *Lepidodendron*, are abundantly found in the shales of the same coal bank.

It is remarkable that Prof. Geinitz, in his Coal Flora (*Versteinerungen*) of Saxony, describes under the name of *Lepidostrobus variabilis*, a species nearly related to our *Lepidostrobus princeps*, and considers it as a cone of *Lepidodendron rimosum*. *Lepidostrobus princeps* could be thus considered as a cone of *Lepidodendron simplex*. But at Colchester, where the specimen of *Lepidodendron* was found, there are no remains of *Lepidostrobus*; and this last species is in plenty at Duquoin, where no specimen of *Lepidodendron* was found. It is well to remark, nevertheless, that both Duquoin and Colchester coal banks are placed at the same geological horizon. Coal No. 3.

A number of specimens of other species of *Lepidodendron*, some apparently new, are preserved in the State Cabinet at Springfield, mostly from Pope county, but most of them are too much broken and obliterated for determination. Among the species already known, there is in the cabinet the following:

Lepidodendron clypeatum, Lsqx. *Geol. Report Penn.*, p. 875, tab. 15, fig. 5, and tab. 16, fig. 7. Locality: Rock Island county.

Lepidodendron obovatum, Sternb. *Vers.*, 1, p. 10, tab. 6, fig. 1. Locality: Same as last.

Lepidodendron Veltheimianum, Sternb. *Vers.*, 1–4, p. 12, tab. 52, fig. 2. Carroll's place, Pope county; Chester group.

One specimen from the same place is referable with doubt to *Lepidodendron gracile*, Brgt., and another to *Lepidodendron elegans*, Brgt.

Genus LEPIDOSTROBUS, Brgt. Cones or catkins of species of *Lepidodendron*, formed by winged sporanges perpendicularly attached all around a common axis, with the wings or blades (*Lepidophyllum*) upraised and imbricated.

Lepidostrobus princeps, Sp. nov. Tab. 45, fig. 1 to 4. Cone large, cylindrical, about one foot long, or more; blades sagittate at the base, lanceolate, taper-pointed, marked with a broad nerve in the middle; pedicel of the sporanges oblanceolate, slightly obtuse, attached to a slender axis. This species, as it was remarked above, is related to *Lepidostrobus variabilis*, figured and described by Geinitz; but the blades of ours are broader, the pedicels bearing sporanges longer and the axis narrower. The name *variabilis* was given to the European species on account of the great variety in the size of the catkins. The American species appears always large—at least, all the numerous specimens collected at Duquoin are as large as fig. 1, which represents only part of a cone, and is already more than one foot long. Fig. 2 and 3 show the transversal sections of a catkin; fig. 4, a detached blade with its pedicel.

Lepidostrobus hastifolius, Sp. nov. Cone about one inch thick; scales densely imbricated, with the blade open, nearly horizontal, at least near the base; blade short, enlarged at the base into two acute, angular, diverging points, ovate-lanceolate, somewhat obtuse at the summit; pedicel of the sporange narrow, linear, acute, a little enlarged above.

This is the cone whose blade I have named *Lepidophyllum hastatum*, *Geol. Rept. Penn.*, p. 876, tab. 17, fig. 7. The preserved part of the cone is about three inches long, but it is broken and its whole length is not known. Locality: Mazon creek, Grundy county. Coal No. 3.

Genus LEPIDOPHYLLUM, Brgt. This genus is preserved for the classification of the fruit-bearing leaves or bladed sporanges of the *Lepidostrobi*, for as far as they are known only in their isolated state, and have not been seen attached to a common axis.

Lepidophyllum lanceolatum, Brgt. Figured and described in the *Geol. Report of Penn.*, p. 875, pl. 17, fig. 1.

Lepidophyllum majus, Brgt. *Prod.*, p. 87. Specimens of this and the former species are in the State Cabinet of Springfield. Locality unknown.

Lepidophyllum auriculatum, Sp. nov. Pl. 36, fig. 6. Blade long, lanceolate, pointed, a little enlarged in the middle, marked by a broad, medial nerve, bearing at the base two small, round auricles; pedicel of the sporanges thick, ovate, enlarged under the blade, a little obtuse at the base. Found at Neelyville, Morgan county.

Genus LEPIDOPHLOYOS, Brgt. Stem cylindrical, bark covered with scales, or by the persistent base of decayed leaves, and marked with broad, rhomboidal scars. The relations of this genus are not well ascertained.

Lepidophloyos obcordatum, Sp. nov. Pl. 41, fig. 1 and 2. Scales lanceolate, truncate, inflated in the middle; scars of the decorticated surface, cordiform, obtuse, overtopped by button-like, round, small crowns, corresponding with the base of the scales. The specimen originally showed the under part of the bark; but by removing accidentally the coat of clay upon which the impressions are marked, the scales were discovered. (Fig. 1, specimen from Duquoin.) Fig. 2 is from a smaller specimen found at Colchester—coal No. 3. In this one the scars have nearly the same general outline, dilated on both sides, obtuse below, showing above a vascular scar about of the same form, marked by three horizontal points.

Genus KNORRIA, Sternb. and Gopp. Stems tree-like, bearing basilar conical remains of nearly imbricated, or closely and spirally placed leaves.

Knorria imbricata, Sternb. *Vers.*, 1, p. 37, Chester group.

FIFTH DIVISION.—STEMS OF FERN TREES.

Genus MEGAPHYTUM, Artis. Stem tree-like, apparently large, furrowed, dotted, marked by large scars of a horse-shoe figure, left by the base of the petioles of large fronds and placed in two or more parallel rows. This definition is somewhat modified from the author's. Our American specimens evidently prove that the scars were left by the petioles of large fronds, and not of branches. This genus is thus, as Prof. Geinitz has already remarked, nearly related to *Caulopteris*. If the name of *Megaphytum* should be appropriated to represent stems bearing scars of undeveloped or adventive branches, following Goldenberg's description of his *Megaphytum giganteum*, a new genus should be established for the classification of our species.

Megaphytum protuberans, Sp. nov. Pl. 47, fig. 1 and 2. Scars convex, elevated, square-oval, slightly emargenate above, marked in the upper part by vascular lines of nearly the form of a reversed horse-shoe; stem irregularly striated and pointed; points of various size and placed without apparent order. Fig. 1 represents a large specimen one-third of natural size; fig. 2 two scars of natural size. It is a beautiful species found in the sandstone under the upper Chester limestone at Carroll's place, Pope county.

Megaphytum McLayi, Sp. nov. Pl. 48, fig. 1. Scars very large, nearly contiguous, flattened, surrounded by a broad, smooth margin, broadly square, somewhat rounded, separated in two by a broad, irregular rib, and marked on both sides by the irregular auriculate impressions of the ducts. I have seen of this remarkable species another specimen similar to the one figured here, and having four scars still larger than these. It was found at St. John, by Mr. John McLay, to whom the species is dedicated, and who fell at the battle of Shiloh, in Tennessee, in defending the cause of his adopted country and human liberty.

Genus CAULOPTERIS, Lindley and Hutt. Stems tree-like, bearing on the surface large, oval, peltate scars, showing the point of insertion of petioles of large fronds of ferns; scars distant, disposed in spiral or in a quincuncial order, surrounded by a broad, simple or double margin (annulus) diversely marked by oval or curved above, and horn-like vascular impressions.

This definition brings together the genera *Caulopteris, Stemmatopteris* and *Ptychopteris* of Corda, for reasons which cannot be discussed here. Species of this genus are rarely found in the Coal Measures. The whole coal flora of Europe has a single species of the section *Stemmatopteris,* and three or four species of the true *Caulopteris.* The coal flora of the United States already counts six species of *Stemmatopteris,* but none referable to the section *Caulopteris.*

Caulopteris insignis, Sp. nov. Pl. 49, fig. 1. Scars very large, exactly oval, bordered by a smooth, broad (about one inch) annules. Vascular scars horse-shoe shaped, with the internal branches descending nearly to the basal line, where they unite in a point, forming a spatulate, pointed or beaked medial rib, with two at first parallel and then diverging semi-lunar appendages; surface smooth, except the rib which is marked by irregular, deep points in its whole length, and in the space between the appendages. The State Cabinet has two specimens of this remarkable species, both from Duquoin. Lower Coal Measures.

From the size of these scars it could be supposed that they were from very large trees. But the marks of the petioles of fern trees are comparatively large. The stem of the following species is ten inches in circumference, and the size of the scars is one-fourth of those of this species. If the proportion in the development of the stem was the same, the tree bearing this cicatrix would have been only about 14 inches in diameter.

Caulopteris Worthenii, Sp. nov. Pl. 50, fig. 1. Stems slender, about three inches in diameter, somewhat compressed; scars distant, round at the base, narrowed, horse-shoe shaped above, with converging branches; vascular scars of the same form as the annules, marked near the base by a semi-lunar obscure appendage. The specimen figured here is replaced by sandstone. It appears to be decorticated; at least the surface is perfectly smooth. The position of the scars is marked by the pointed lines, *a*, *b*, *c*, fig. 1. The lower scar, *a*, is figured 1 *b*, and has a different form from the upper one, 1 *a*. The scars at *b* and *c*, fig. 1, are obsolete, scarcely visible, and consequently the true disposition of the leaves is only supposed. It appears to be nearly in one-fourth. Fig. 1 *c* is the cross section of the stem, natural size. Found at Carmi, White county.

SIXTH DIVISION.—FRUITS OR NUTLETS.

Genus TRIGONOCARPUM, Brgt. Fruit ovoid, three or six costate, generally marked at the point of attachment by a hexagonal depression.

Trigonocarpum juglans, Sp. nov. Pl. 46, fig. 3. Fruit of large size, about one inch and a half in diameter, nearly round, apparently three ribbed; ribs elevated, sulcate; surface nearly smooth, slightly striated or marked by narrow, distant lines, parallel to the ribs. The figure shows all that can be seen of the preserved part of this fruit. Found in a piece of iron shale at Murphysboro, Jackson county. Lower Coal Measures.

Trigonocarpum rostellatum, Sp. nov. Pl. 46, fig. 6. Fruit oval, a little flattened, three ribbed only near the point, which is curved in a short beak; lower part of the fruit round and smooth. Locality: Grayville, White county. Upper Coal Measures.

Genus CARPOLITHES, Sternb. Fruits of various forms and of doubtful affinity.

Carpolithes multistriatus,? Sternb. Pl. 46, fig. 2. I refer this fruit with doubt to the species figured by Sternberg, *Vers.*, vol. 2, tab. 39, fig. 1 and 2. The American form is longer, more evidently pointed at the base, more obscurely ribbed. It is oblong, nearly two inches long, apparently originally inclosed in a large shell or woody envelope transformed into coal. It is remarkable that in our fruit, as in figure 1 of Sternberg's, the envelope of coal matter appears to be extended above or around the fruit by a kind of frame looking like a part of a destroyed envelope. Locality: Unknown. Specimens of the true *C. multistriatus* have been found at Colchester. They are broader but shorter than this described form, and do not have any trace of the coaly envelope.

Carpolithes Jacksonensis, Sp. nov. Pl. 46, fig. 4. Fruit about two inches long, one inch broad, ovate, oblong, pointed, marked with six? elevated ribs. This species is not rare in coal No. 1 B. It may be, perhaps, referable to *Carpolithes sulcatus*, Sternb., though far different in general outline. Locality: Murphysboro, Jackson county. Lower Coal Measures.

Carpolithes cistula, Sp. nov. Pl. 46, fig. 5. (From a specimen in my cabinet, found at Murphysboro.) This fruit, which in general outline is about square-oblong, appears formed of three parts: an outer, broad or thick envelope; a medial one, apparently hard and thin, replaced in the specimen by a thin coat of coaly matter; an inner kernel or fruit, elliptical, inflated or convex, smooth and marked in the middle by an irregular rib.

Carpolithes fasciculatus, Sp. nov. Pl. 46, fig. 7. Fruits generally flattened, smooth, oval, short-pedicelled, marked in the middle by a short, narrow furrow. A common species, found especially in the high coal. These fruits are generally three, four or more together in close proximity, as if they had been attached to a common pedicel or in bunches. I have nevertheless not been able to see them in a more evident connection than in the specimen copied, fig. 7. Is plenty at Grayville, White County; Upper Coal Measures.

SEVENTH DIVISION.—ROOTS OR ROOTLETS.

Genus PINNULARIA, Lindl. and Hutt. Irregularly branching filaments, of various forms and sizes, have been classed under this name. One of them, with numerous thread-like, irreguar branches, *Pinnularia capillacea*, Lindl. and Hutt., is very abundant in the coal shales, especially with coal No. 3. The State Cabinet has numerous specimens of it.

It may not be out of place to mention here the remarkable *Gyromices ammonis*, Gopp. Pl. 38, fig. 6, 6*b*. A spiral, organized body, which has been referred, by Prof. Goppert and other German authors, to a species of *fungus*, found under or within the coaly matter of some leaves and stems of the coal shales. This species is abundant at Colchester with the remains of various plants, under the leaves of *Callipteris Sullivantii*, *Pecopteris*, *Stigmaria*, *Cordaites*, etc. It is true that these remains appear sometimes within the coaly matter of the plants, or imbedded in it, a circumstance which may have led the German Palæontologists to consider the species as a *fungus*. But in most instances, these small bodies have left their prints deeply marked, or rather their casts, in the shales, under the coaly matter of the leaves. Their substance was consequently hard. It is thus easy to understand that if ever they lived under the leaves or floating stems, the pressure has forced them sometimes within the softened substance of the leaves and stems, as it has forced them within the clay. I have examined many specimens of this species under divers circumstances of position, etc., and cannot consider them but as the small, thick shells of an Annelid. Professor Dawson, of Montreal, who examined this species a long time ago, has considered it in the same light, and named it *Spirorbis carbonarius*. The shell makes about two spiral turns, and is marked crosswise by strong ribs, each separated by three or four thinner ones. Fig. 6 shows a cross section of the species. Fig 6 and 6 *a* are enlarged ten diameters.

SUMMARY.

Only 120 species of fossil plants are named and described in the above enumeration.* Is not this number very small, and shall we not admit at once that the fossil flora of the coal fields of Illinois is extremely poor? Before coming to such a conclusion, and to arrive at a better understanding of the general flora of our American coal fields, we had better, I think, compare the distribution of the species of Illinois, in their different genera, with those of Ohio and Pennsylvania, as far as they were known when my catalogue of Fossil plants was published in 1858. This is easily done in the following table:

GENERA.	Whole number of species in Illinois.	Number of new species in Illinois.	Species found in Illinois, not published before.	Species published in catalogue and not found in Illinois.	Whole number of species in catalogue.	New species in the same.
1. Noeggerathia †	0	0	0	6	6	4
2. Cyclopteris	0	0	0	2	2	1
3. Neuropteris	17	4	5	16	28	13
4. Odontopteris	4	3	4	7	7	3
5. Dictyopteris ‡	0	0	0	1	1	0
6. Sphenopteris	6	1	3	23	27	18
7. Hymenophyllites	5	2	4	7	8	7
8. Alethopteris	6	2	4	13	15	8
9. Callipteris	1	0	0	0	1	1
10. Pecopteris	15	1	6	18	25	11
11. Crematopteris	0	0	0	1	1	1
12. Scolopendrites	0	0	0	1	1	1
13. Schizopteris	0	0	0	1	1	1
14. Cannophyllites	0	0	0	1	1	1
15. Cordaites	1	0	0	0	1	0
16. Sphenophyllum	2	0	0	7	9	5
17. Annularia	2	0	0	2	4	0
18. Asterophyllites	4	0	1	6	9	5
19. Calamites	7	0	0	7	14	2
20. Artisia	1	0	1	0	0	0

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* Since this examination was made (1860), the number of species of the Illinois fossil flora has been increased by the discovery of more than 30, mostly new species, to be published hereafter.

† All the species of the genus *Noeggerathia*, as I have limited it, belong to the old red sandstone. There is no trace of it in the western coal basin.

‡ Our only species of American *Dictyopteris* is abundant in Pennsylvania, Ohio, Kentucky, and even in Arkansas, and should have been found already in Illinois. It is a local species, always found in plenty, but in surfaces of small extent, and rather appearing in the low Coal Measures.

GENERA.	Whole number of species in Illinois.	Number of new species in Illinois.	Species found in Illinois, not published before.	Species published in catalogue and not found in Illinois.	Whole number of species in catalogue.	New species in the same.
21. Selaginites	3	2	3	0	0	0
22. Lycopodites	1	1	1	0	0	0
23. Stigmaria	6	1	4	4	7	5
24. Sigillaria	8	1	2	31	37	19
25. Syrigodendron	1	0	0	2	3	1
26. Lepidodendron	12	6	8	14	18	10
27. Lepidophloyos	1	1	1	2	2	0
28. Diplothegium	0	0	0	1	1	0
29. Ulodendron	0	0	0	2	2	0
30. Megaphytum	2	2	2	1	1	0
31. Caulopteris	2	2	2	3	3	1
32. Knorria	1	0	0	2	3	2
33. Lepidostrobus	2	2	2	4	4	1
34. Lepidophyllum	3	1	2	5	7	6
35. Brachyphyllum	0	0	0	1	1	1
36. Cardiocarpon	0	0	0	9	9	8
37. Rhabdocarpos	0	0	0	3	3	2
38. Trigonocarpum	2	2	2	7	7	4
39. Carpolithes	4	3	3	9	10	4
40. Pinnularia	1	0	0	0	1	0
	120	37	60	219	280	146

To this comparative table I will only add a few remarks. The whole number of species hitherto known from all the coal fields of the United States, is not much over four hundred.

Most of the species of our American coal plants have been collected in Pennsylvania, where the coal is extensively worked, not only over the whole extent of the coal fields, but in the different stages of the measures.

In Illinois, on the contrary, the coal is worked at a few places only, and most of the banks hitherto opened are roofed either with limestone or with calcareous shales, having an abundance of animal remains, but no plants.

In some parts of the Eastern coal fields, especially in Pennsylvania and Ohio, a number of Geologists and of amateurs interested in the advancement of botanical palæontology, have for many years given their attention to the collection of fossil plants, and have preserved the specimens, either in private cabinets or public museums. In Illinois very few persons appear to have collected fossil plants from scientific interest, and it is evident from what I have seen myself in the coal mines of Colchester and Duquoin, that the want of a more general interest in the collection and study of the coal plants, is the main reason of the apparent deficiency of species indicated by the table.

From the collections made by Prof. A. H. Worthen, Mr. Joseph Even and myself, there have been procured already some data which are worth recording.

The number of new species, including those which, though described from Europe, are new for America, is already proportionally as great as in the enumeration of the coal plants of Pennsylvania—fully 50 per cent. This is a new evidence of the riches of the American coal flora. It proves, at the same time, that we are acquainted only with a small number of species of fossil plants, compared with what we may expect to find hereafter.

The numerous and remarkable new species found within the ironstone concretions of Grundy county seem to indicate that the fossil plants preserved in the shales and sandstone of our Coal Measures represent only a part, and perhaps a proportionally small one, of the whole flora of the Carboniferous epoch. The maceration has apparently entirely destroyed all the species whose tissue was not hard and woody. Some of these soft remains have been left in broken pieces, as the nuclei of iron concretions; but many, without doubt, will remain always unknown to us. This conclusion is already indicated by the great amount of fruits or nutlets which we find in various strata of the Coal Measures, and which can not be referred to any species known to us by their leaves or other organs.

In considering the fossil plants of Illinois according to their stratigraphical and geographical distribution, we may still remark:

1st. That in Illinois we have, for the first time, the opportunity of studying the plants of Carboniferous strata lower than the Millstone grit (from the Chester group of the Subcarboniferous series). The plants collected in Randolph and Pope counties, though found in the Subcarboniferous measures, are mostly species of *Lepidodendron*, *Knorria* and *Stigmaria*. All are of the true Carboniferous type; some of them even, especially all the *Stigmaria*, ascend high in the true Coal Measures above the millstone grit, thus indicating for the low coal an identity of formation by an identical vegetation.

2d. That the predominance of large vegetables of the Lycopodiaceæ, viz: The *Lepidodendron* is remarkable in these Subcarboniferous strata of Illinois, and strengthen the conclusion already taken from the examination of the Coal Measures of other States: that the flora of the lower coal was essentially composed of large species of *Lepidodendron*, and that these were subsequently replaced by other species or genera. To confirm this opinion we have only to compare the Subcarboniferous fossil flora of Pope county with that of Colchester, Duquoin and Mazon creek, three coals whose geological horizon is near the base of the Mahoning sandstone. Here we have scarcely any species of *Lepidodendron*, a few *Sigillaria* of the section of the *Leiodermaria*, and of small size, and a proportionally very large number of ferns. This peculiar distribution of fossil remains of plants being, in Illinois, in perfect accordance with what has been observed in the Coal Measures of other States, evidently shows that the varieties of vegetation are not due to peculiar and local influences, or to peculiar botanical zones, but are truly in concordance with the different horizons of the Coal Measures, and thus indicate successive or different formations. If, then, we were all to study and to know the plants which have contributed to the formation of each bed of coal, the remains of these plants, when found in the shales, would always indicate a peculiar horizon.

3d. The examination of the coal flora of Illinois proves the identity of vegetables in the whole American coal fields. The only fossil plant described from the Nova Scotia Coal Measures, which had not yet been found in Pennsylvania and Ohio, viz: *Odontopteris subcuneata*, has been found at Mazon creek. The plants of this last place are mostly identical with those of Newport, Rhode Island. Those of coal No. 3, at Colchester and Duquoin, are also mostly the same as those of the Haddoc coal bank at Breathett, Kentucky, of South Salem vein of Pottsville, Pennsylvania, of Stark county coal in Ohio, etc. Thus, I think, we can readily admit that the contemporaneousness of formation is recognizable over the whole extent of our coal fields, not only on a general point of view, but even considering each separate bed of coal.

APPENDIX.

SINCE 1863, when my report was delivered, I have had opportunity to examine a large number of specimens, found in the iron concretions of Mazon creek, near Morris, Grundy county.[*] As the species of a certain locality, compared with the number of specimens in which they are represented, give us a pretty fair insight into the vegetation of the coal epoch, at least for a peculiar horizon, it may be interesting to have enumerated in a table all those which, to my knowledge, have been found in that remarkable locality.

	No. of spec.
1. Neuropteris hirsuta, Lsqx	120
2. “ Clarksoni, Lsqx	1
3. “ flexuosa, Brgt.[†]	1
4. “ plicata, Sternb	1
5. “ Loschii, Brgt	4
6. “ vermicularis, Lsqx	2
7. “ tenuifolia, Brgt.[‡]	2
8. “ rarinervis, Bunb	16
9. Neuropteris Desorii, Lsqx	1
10. “ fimbriata, Lsqx.[§]	1
11. “ Evenii, Lsqx	2
12. “ pachyderma, Lsqx	2
13. “ inflata, Lsqx	2
14. “ verbenæfolia, Lsqx.[‖]	4
15. Odontopteris Wortheni, Lsqx	3
16. “ subcuneata, Bunb	4

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[*] Especially in the cabinet of Prof. J. D. Dana, of New Haven, of Schenectady College, and of Mr. Even, at Morris; this last remarkable indeed for the number and beauty of the specimens.

[†] An obscure specimen only; it may be a large form of *Neuropteris Loschii*.

[‡] This species is abundant in the shales above and below the upper coal at Morris, and also at Colchester.

[§] A fine specimen of this species, with alternate leaves attached to the rachis. This species, rare in Illinois, is common in the iron concretions between Athens and Marietta, Ohio, at the same horizon.

[‖] From specimens in Mr. Even's cabinet at Morris. The species appears bipinnately divided; the alternate leaflets of the same form as the one described and figured in

		No. of spec.
17.	Odontopteris æqualis, Lsqx	2
18.	Sphenopteris rigida, Brgt	2
19.	" trifoliata, Brgt	1
20.	" latifolia, Brgt	1
21.	" abbreviata, Lsqx	1
22.	Hymenophyllites Clarkii, Lsqx	12
23.	" hirsutus, Lsqx	1
24.	Alethopteris Massillonis, Lsqx.*	1
25.	" Owenii, Lsqx.†	1
26.	" Serlii, Brgt	5
27.	" Coxiana, Lsqx	9
28.	" crenulata, Brgt	10
29.	" rugosa, Lsqx	1
30.	" Pluckneti, Brgt	3
31.	" nervosa, Brgt	1
32.	" pectinata, Lsqx.‡	1
33.	" stellata, Lsqx	1
34.	Callipteris Sullivantii, Lsqx	10
35.	Pecopteris pteroides, Brgt	1
36.	" Cistii, Brgt	1
37.	" polymorpha, Brgt	2
38.	" villosa, Brgt	185
39.	" oreopteredis, Brgt	3
40.	" arborescens, Brgt	3
41.	Pecopteris lepidorrhachis, Brongt. (stems)	2
42.	" cyathea, Brgt	1
43.	" unita, Brgt	65
44.	" Grandini, Brgt	2
45.	" plumosa, Brgt	6
46.	" Murrayana, Brgt	4
47.	" Newberryi, Lsqx	3
48.	Cordaites borassifolia, Ung	1
49.	Sphenophyllum Schlotheimii, Brgt	10
50.	" emarginatum, Brgt	4
51.	Annularia longifolia, Brgt	26
52.	" sphenophylloides, Ung	12
53.	Asterophyllites longifolius, Brgt	1
54.	" rigidus, Sternb	2
55.	" equisetiformis, Bgt	15
56.	" foliosus, Lindl. and Hutt.§	4
57.	" sublævis, Lsqx	4
58.	" lanceolatus, Lsqx. (fruit)	2
59.	Calamites nodosus, Brgt	4
60.	" approximatus, Brgt	2
61.	Selaginites cavifolius, Lsqx	2

the report, vary in size from one to three inches long. To the genus *Neuropteris* should be added some specimens of the formerly admitted genus *Cyclopteris* var. *Cyclopteris obliquua*, Brgt., and *Cyclopteris ingens*, Lindl. and Hutt., both found at Morris. The first is referable with doubt to *Neuropterus hirsuta*, the second to *Neuropteris rarinervis*. I have seen six specimens of this last form, and ten of the first.

* An obscure specimen. May represent a form of *Alethopteris aquilina*, Brgt., which is abundant in the shales of the coal at Morris, and of that of Neelysville and Duquoin.

† A poor specimen. May be referable to *Alethopteris Coxiana*, Lsqx.

‡ A new species, sent for determination, by Mr. Wilbur, of Chicago. It is a fruiting frond, lanceolate, taper pointed in outline, bipinnately divided. The pinnæ are linear, narrow, undulating, rather turned upwards from the middle, with a narrow rachis; the pinnules are very narrow, short, linear, obtuse, deeply marked in the stone, very numerous, perpendicular to the rachis, with a strong medial nerve, veinlets obsolete. In the upper part of the frond the pinnæ decreases in size and pass into simple pinnules. On the same stone there are a few detached pinnules of *Alethopteris Coxiana*. The new species might be its fruiting frond, though there is no likeness whatever in the leaflets.

§ Most abundant in stems and floating roots in the shales under the coal at Morris.

	No. of spec.
62. Selaginites crassus, Lsqx	1
63. Lycopodites asterophyllitæfolius, Lsqx	1
64. Stigmaria Evenii, Lsqx.*	2
65. Lepidodendron simplex, Lsqx	1
66. Lepidostrobus princeps, Lsqx	3
67. " hastifolius, Lsqx	2
68. Lepidostrobus lanceolatus, Brgt	1
69. Carpolithes multistriatus, Sternb †	1
70. Pinnularia capillacea, Lindl. and Hutt	4
71. " fucoides, Lsqx	2

Seventy-one species, represented by 614 specimens.

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* It is worth remarking that *Stigmaria* is generally absent in the shales and concretions of coal No. 3. This may account for the absence of species of large *Sigillaria*. The deep part of the swamps appear to have been filled mostly with stems, floating branches or roots, and leaves of *Asterophyllites foliosus*.

† A remarkable specimen, sent also for determination by Mr. Wilbur. The end of the fruit is truly flattened by a deep impression of a leaf of *Callipteris Sullivantii*, proving that even the hardest veinlets have been softened to a mere paste by the process of emerecausis, or slow combustion in water.

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ERRATA.

Page 61, 15th line from bottom, for "D. gracillis" read "D. gracilis."

Page 71, 9th line from bottom, for "exuvæ" read "exuviæ."

Page 81, 10th line from top, for "Strophodus tanuis" read "Strophodus tenuis."

Page 114, 4th line from bottom, for "spacies" read "species."

Page 124, 17th line from bottom, for "stringent" read "strongest."

Page 126, 10th line from bottom, for "Ctenocanthus" read "Ctenacanthus."

Page 131, 6th line from top, for "Ch. loriformus" read "Ch. loriformis."

Page 135, 3d line from bottom of note, for "above the middle" read "near base of Coal Measures."

Page 137, 11th and 14th lines from top, for "Opisthocælian" read "Opisthocœlian."

Page 138, 2d line from top, for "Borborocætes" read "Borborocœtes."

Page 146, 12th line from bottom, for "Gonialite" read "Goniatite."

Page 150, 1st line at bottom, for "species" read "specimens;" also, 18th line from bottom, as well as 5th line from top, of p. 165, for "palœontologists" read "palæontologists."

Page 152, 3d line from bottom, for "graulose" read "granulose;" and 12th line from top, for "hexigonal" read "hexagonal."

Page 153, 15th line from bottom, for "Rynchonella" read "Rhynchonella."

Page 160, 6th line from top, for "1810" read "1808;" and 7th line, for "II, p. 174," read "I, p. 50."

Page 167, 4th line from top, for "Miller" read "Munster."

Page 191, 5th line from top, strike out "the" after "Batocrinus;" and 14th line from bottom, for "Prelim" read "Berlin."

Page 202, 8th line from bottom, for "abconical" read "obconical."

Page 218, 9th line from top, for "supraradials 3 or 4 x 10" read "supraradials 2 x 10;" and 2d line from below, for "over the interradial and anal spaces" read "over the axillary spaces."

Page 240, 1st line at top, insert "is" before "like Scaphiocrinus simplex;" 2d line, insert "but" before "differs."

Page 263, insert "Dichocrinus constrictus, M. and W.," between the 9th and 10th lines from top.

Page 272, 9th line from bottom, strike out the "?" after "Body."

Page 280, 13th line from top, for "1814" read "1812;" and 14th line, for "tab. 68" read "I, p. 53."

Page 299, 4th line from top, for "Dorsal valve" read "Ventral valve."

Page 364, 8th line from top, for "shell smoother" read "shell smooth."

Page 396, 11th line from top, for "sim- eyes" read "simple eyes."

Page 415, 13th and 15th lines from top, for "Saganella" read "Sagenella."

Explanations of Pl. X, 4th line from top, for "angustas" read "angustus."

N. B.—A few errors and omissions in the references in the text, to particular figures on some of the plates, are corrected by the explanations of the plates.

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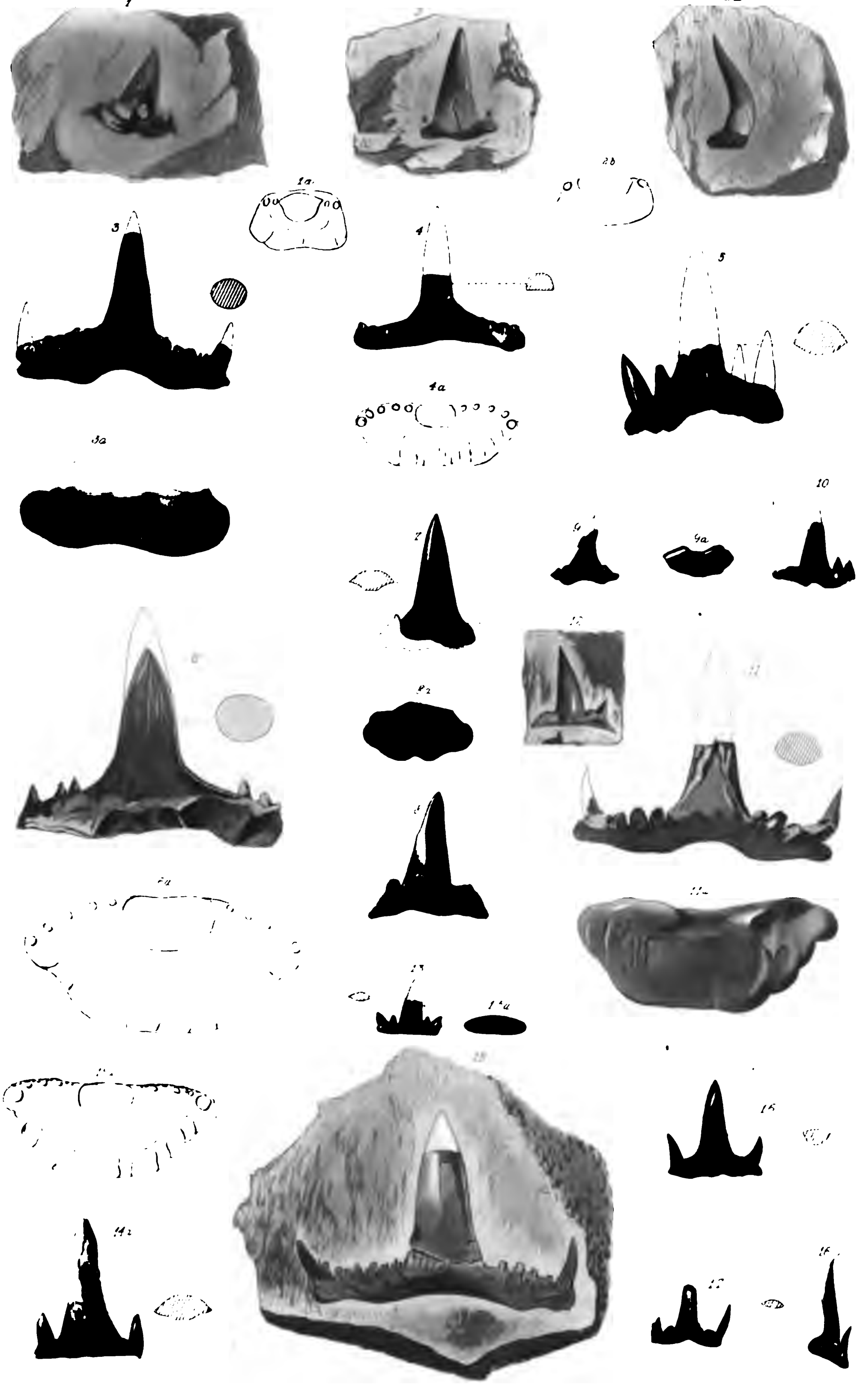

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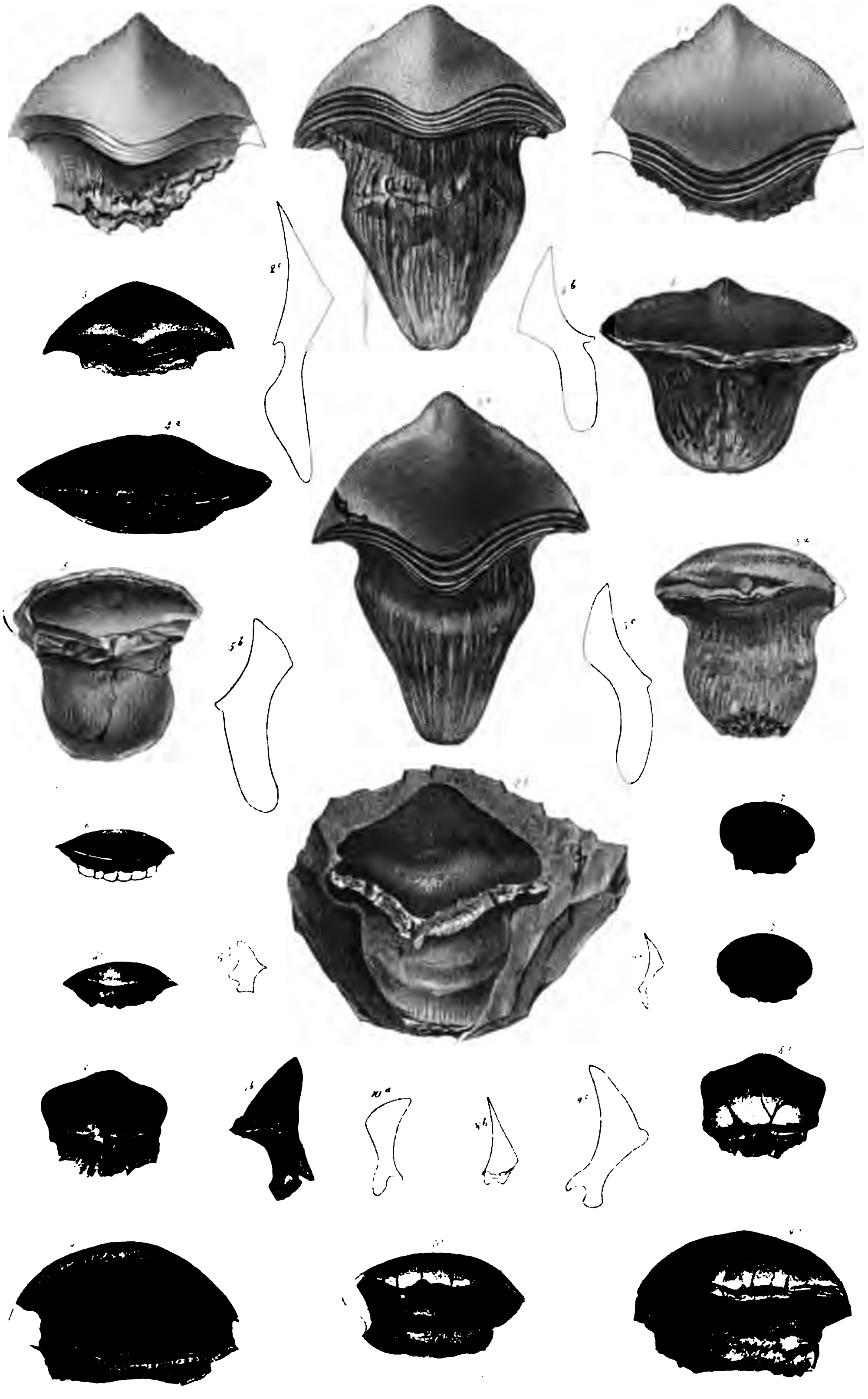
CARBONIFEROUS. (Sub-Carboniferous & Coal Measures.) **FISHES.**



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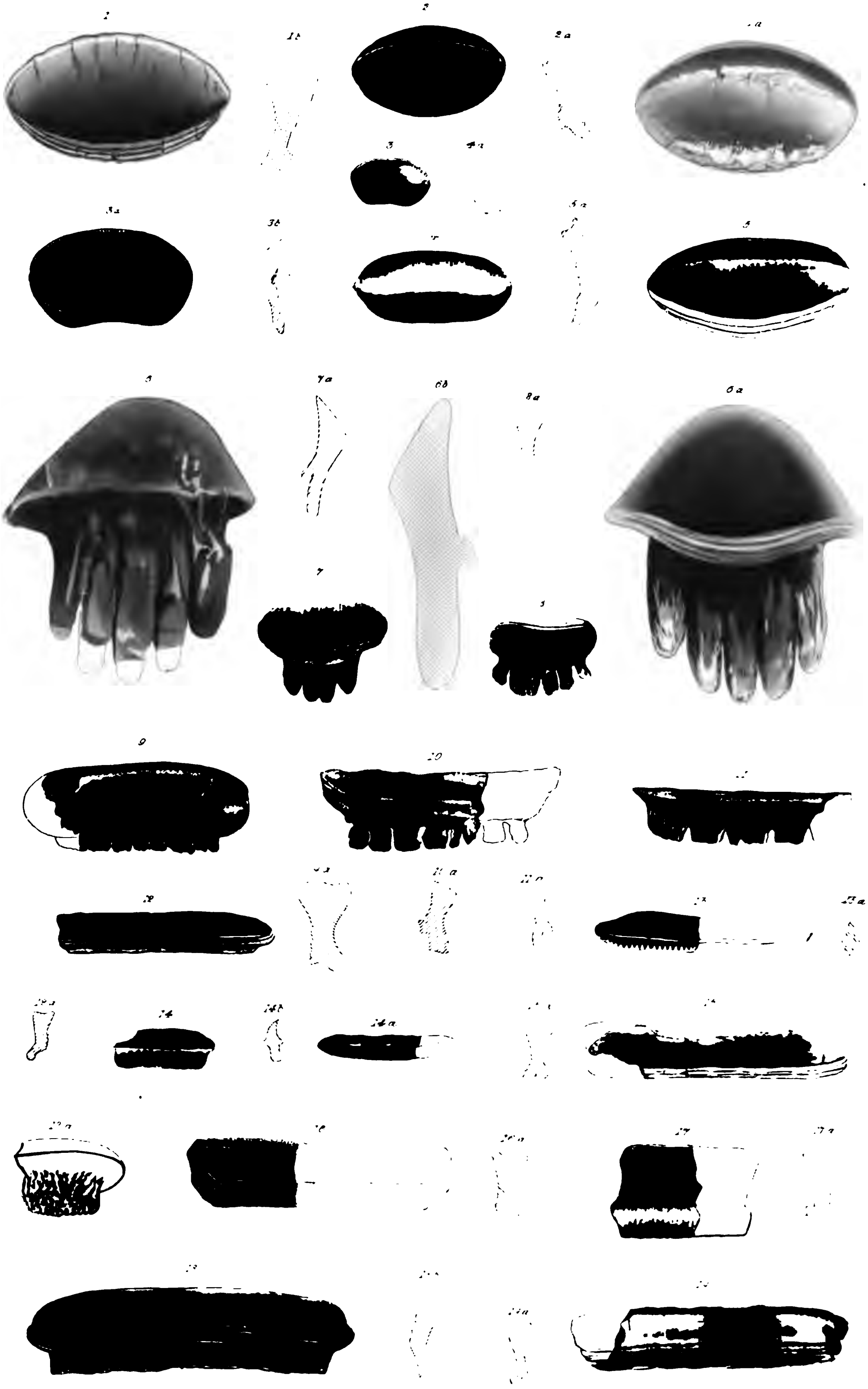

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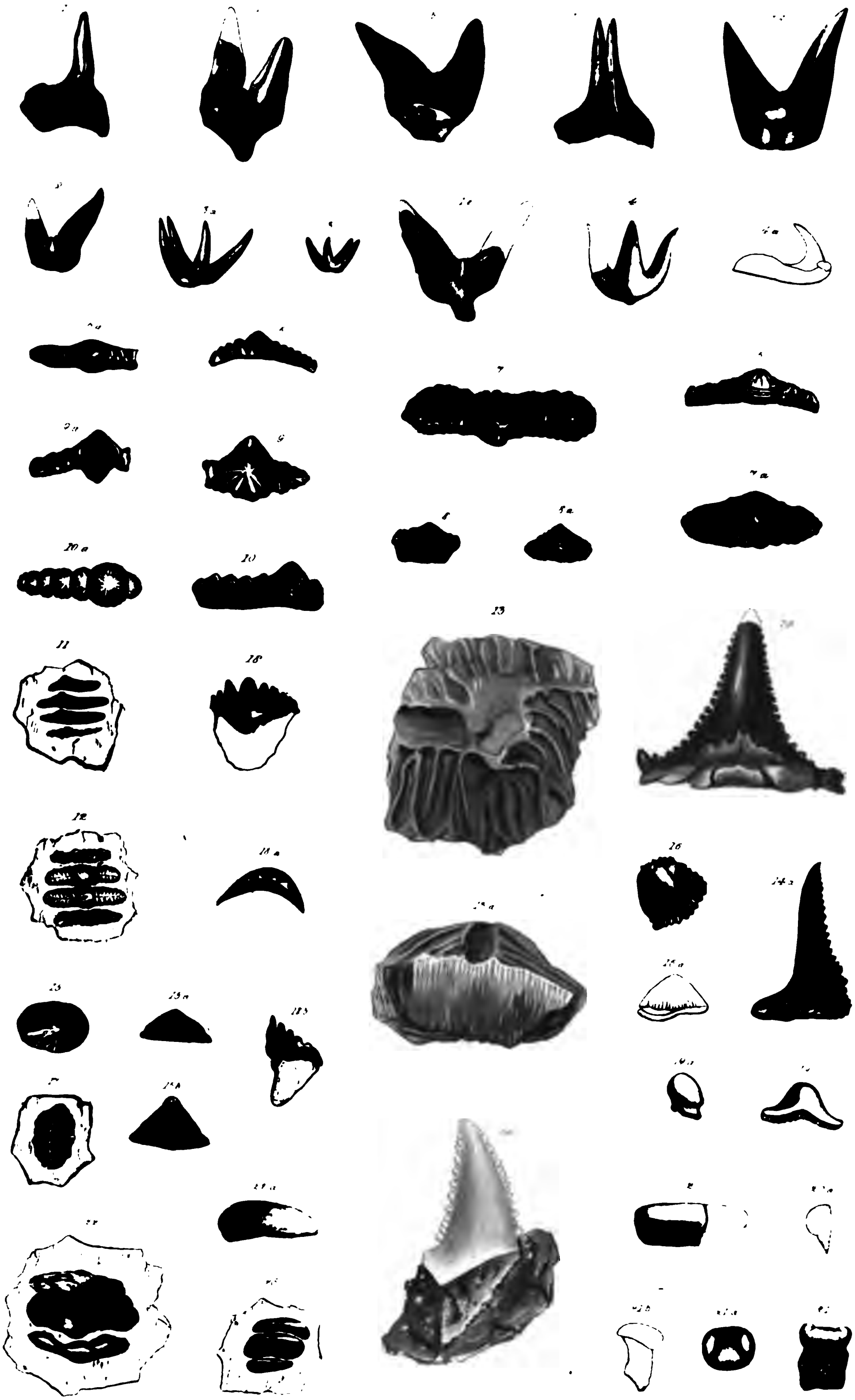

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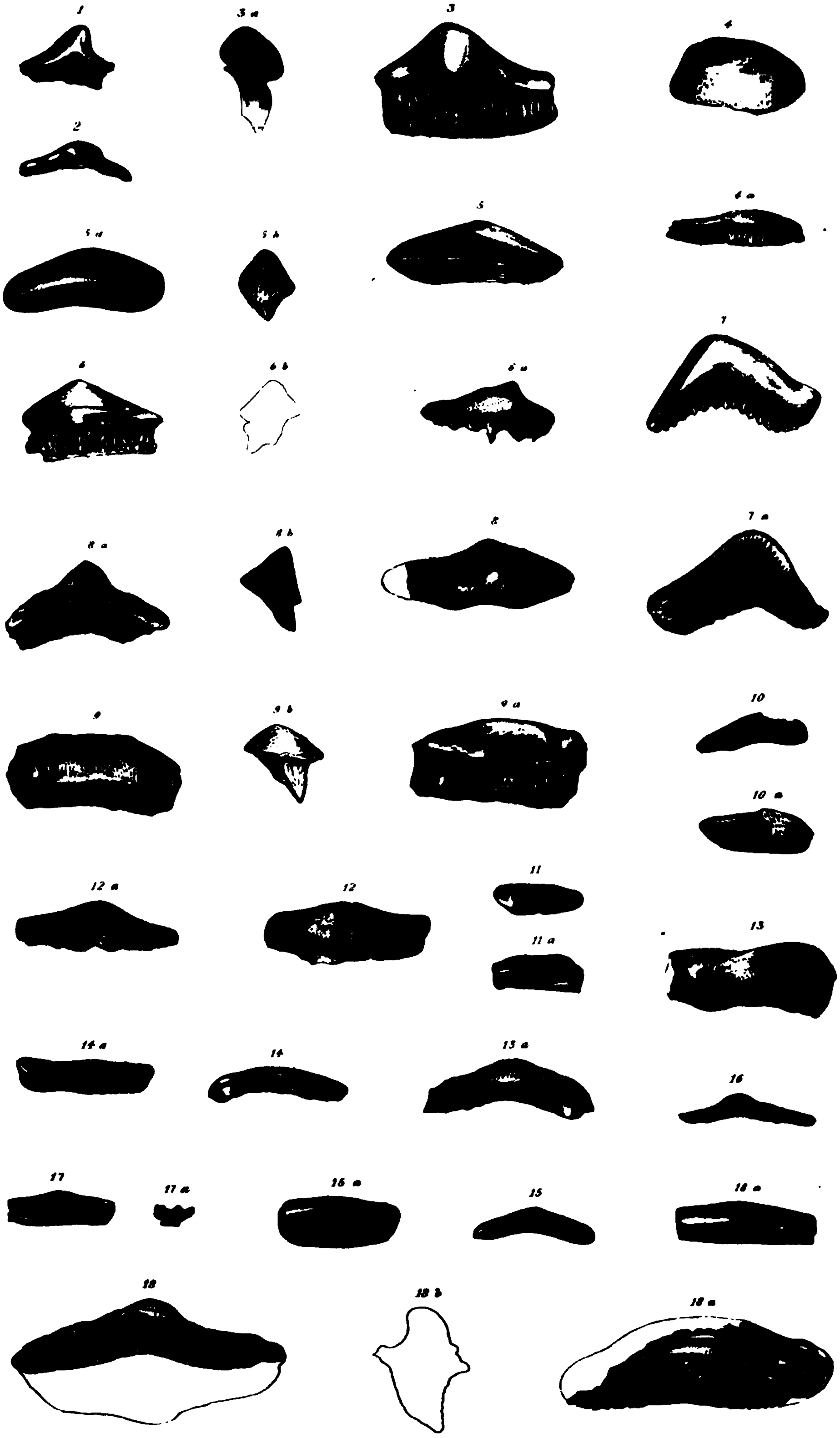

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GEOLOGICAL SURVEY OF ILLINOIS.

CARBONIFEROUS. (Keokuk Limestone.) FISHES.

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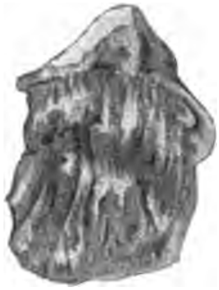

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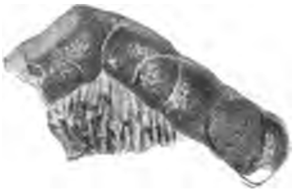

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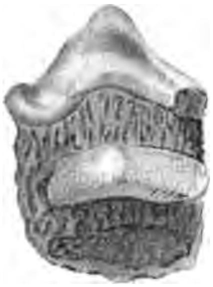

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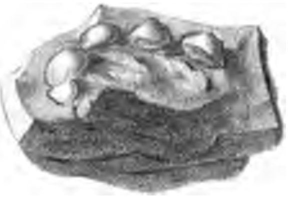

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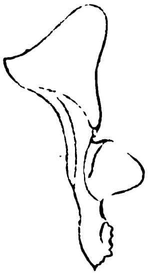
1 b



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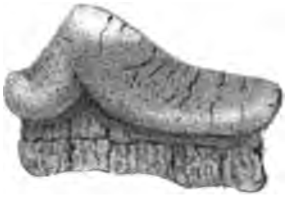

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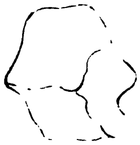

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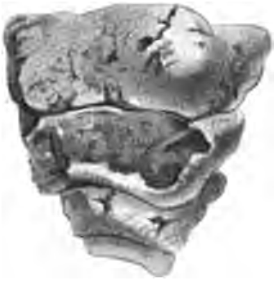

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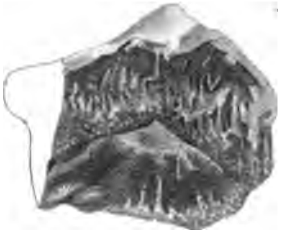

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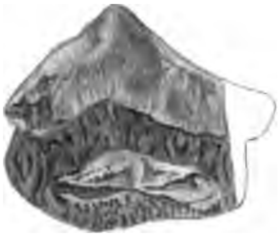

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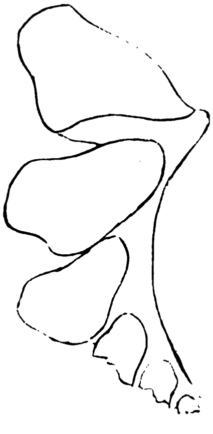

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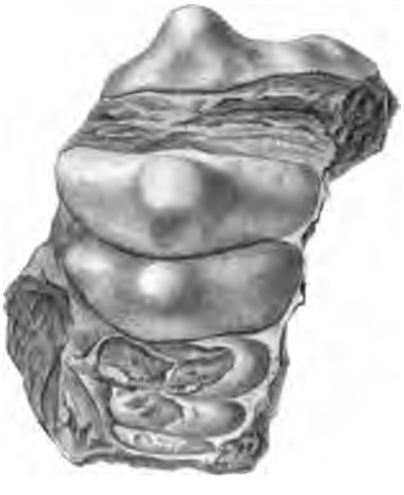

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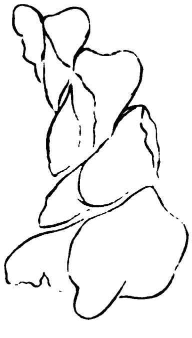

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PLATE VII.

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2.	Terminal tooth of upper jaw, ? right side, ? upper surface.	
3.	Terminal tooth of lower jaw, ? left side?	
3 *a*.	Profile of same.	
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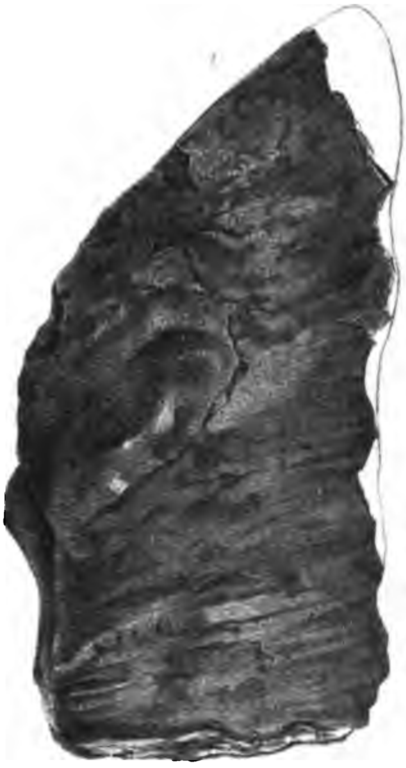
GEOLOGICAL SURVEY OF ILLINOIS.

CARBONIFEROUS. (Keokuk Limestone.) **FISHES.**

1



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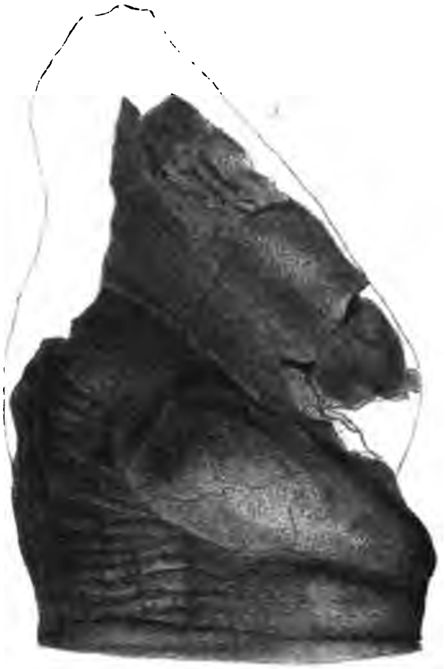

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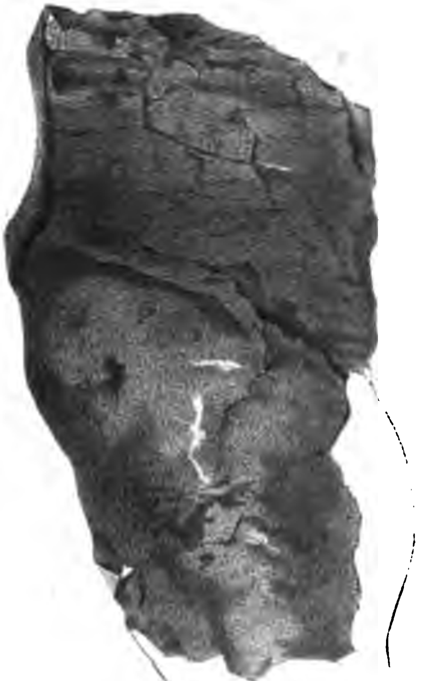

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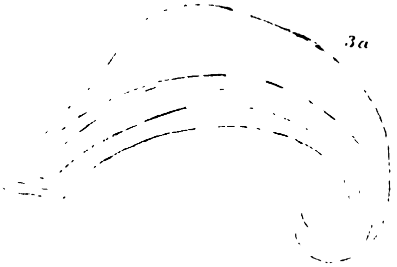

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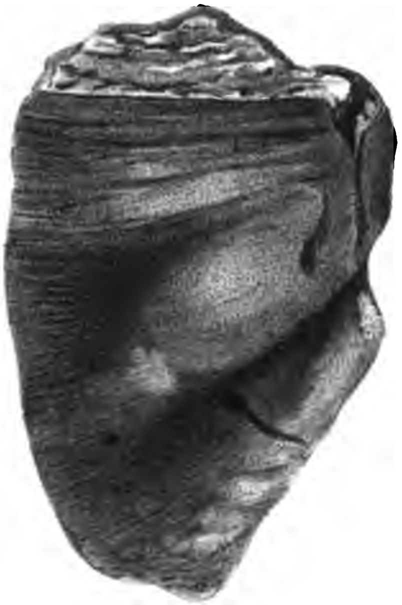

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CARBONIFEROUS. (Sub-Carboniferous) FISHES.

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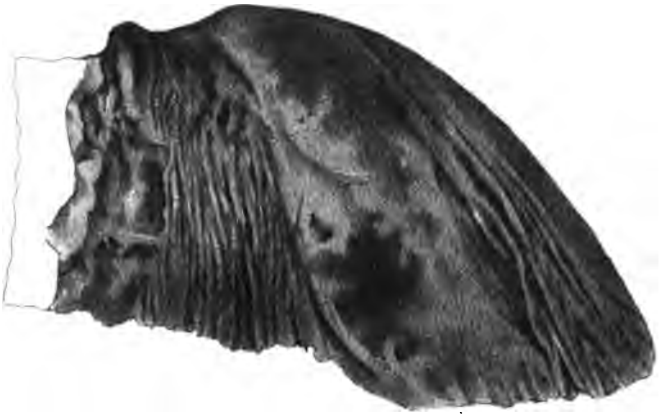

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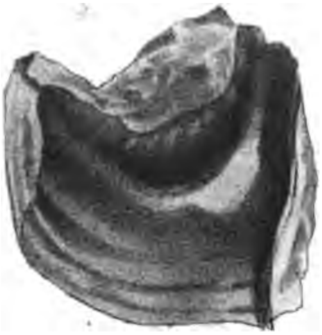

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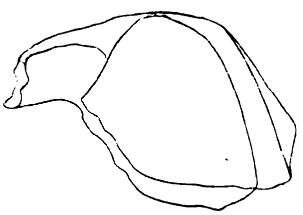

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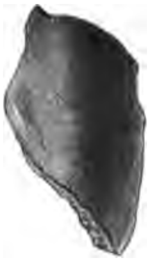

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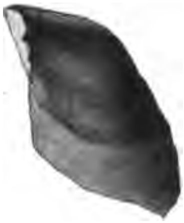

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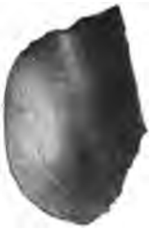

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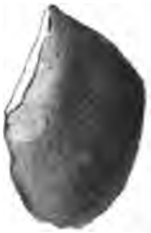

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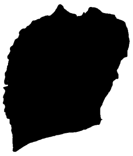

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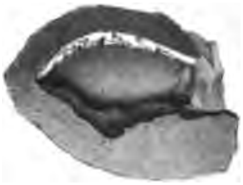

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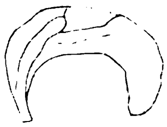
5a

12a



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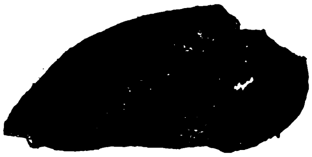

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9*a*. Profile.

GEOLOGICAL SURVEY OF ILLINOIS.

CARBONIFEROUS. (Sub-Carboniferous & Coal Measures.) FISHES.

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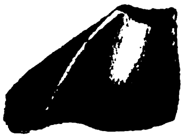

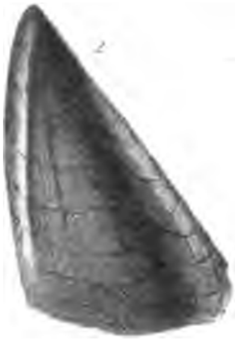

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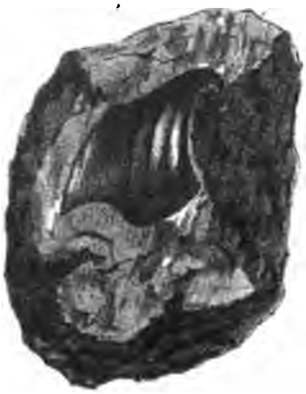

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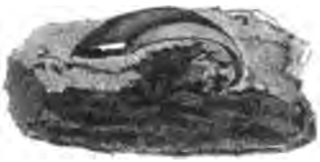

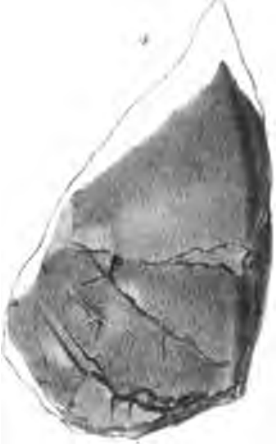

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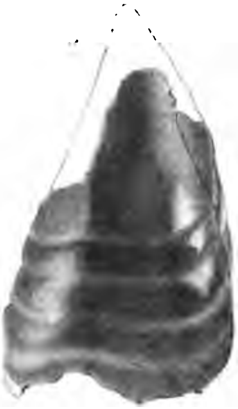

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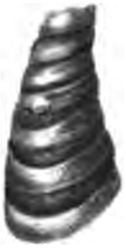

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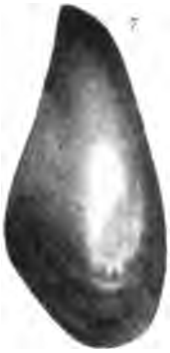

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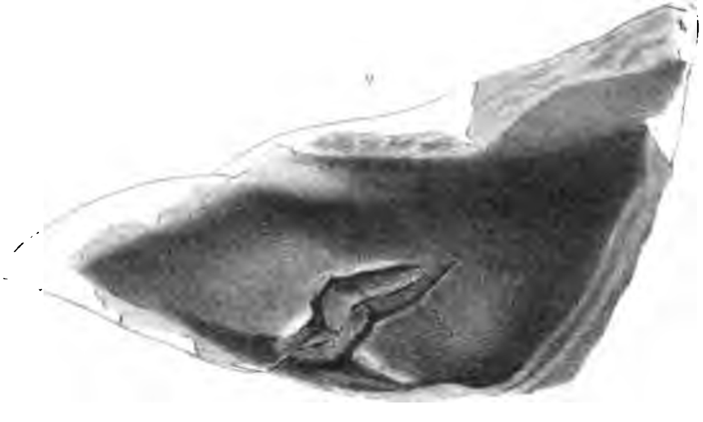

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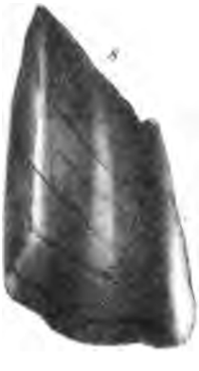

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GEOLOGICAL SURVEY OF ILLINOIS.

CARBONIFEROUS & DEVONIAN. FISHES.

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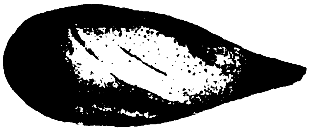

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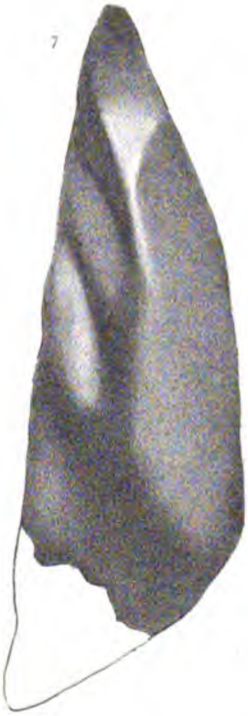

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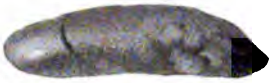

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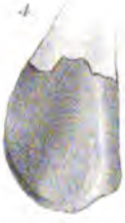

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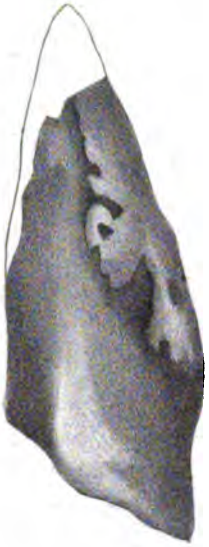

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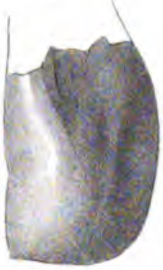

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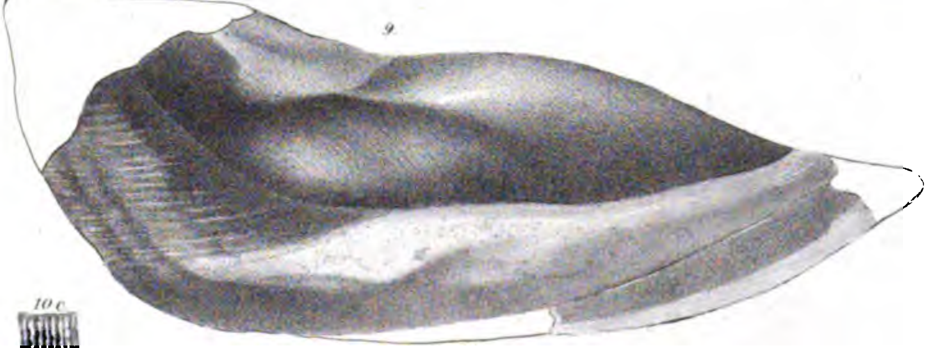

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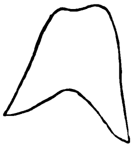

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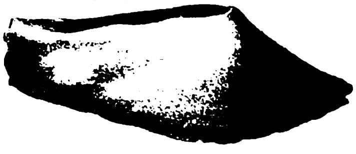

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GEOLOGICAL SURVEY OF ILLINOIS.

CARBONIFEROUS. (Sub-Carboniferous) **FISHES.**

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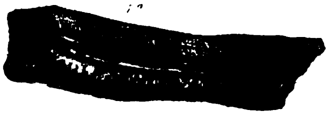

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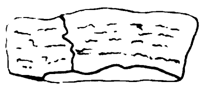

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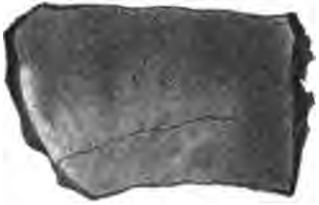

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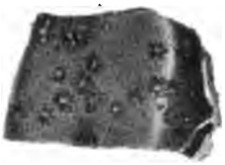

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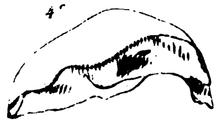

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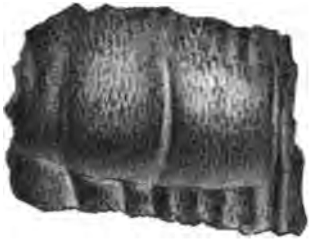

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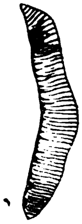

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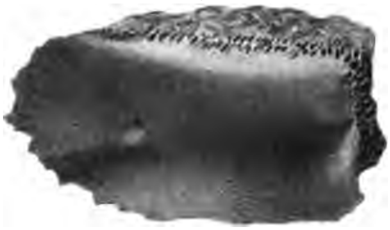

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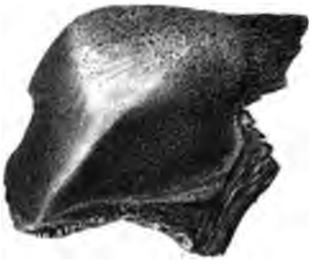

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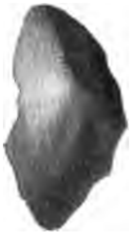

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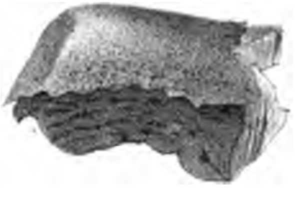

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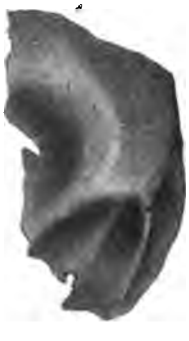

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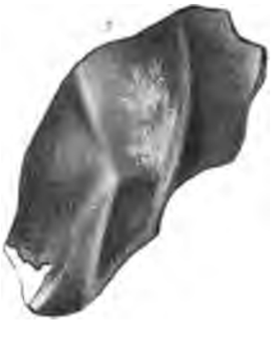

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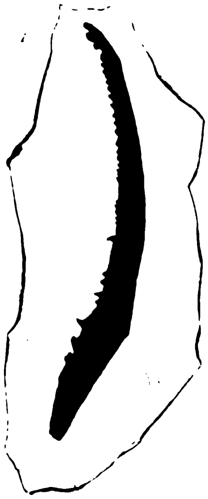
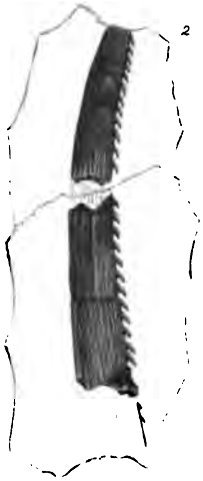
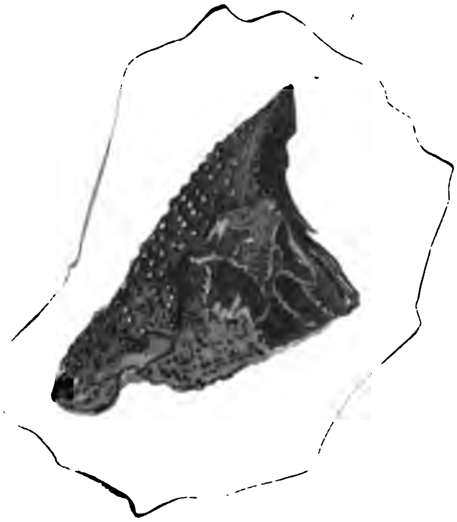
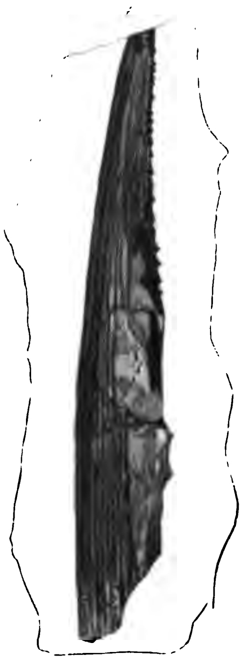
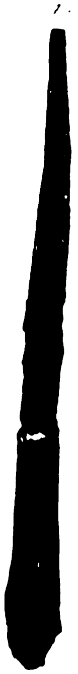
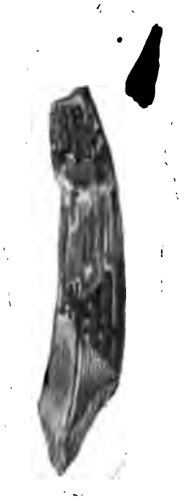
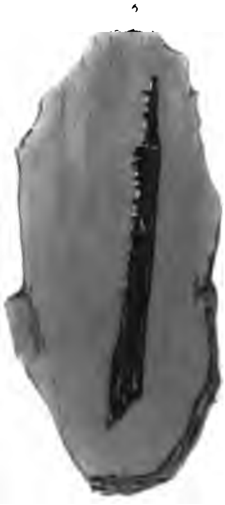
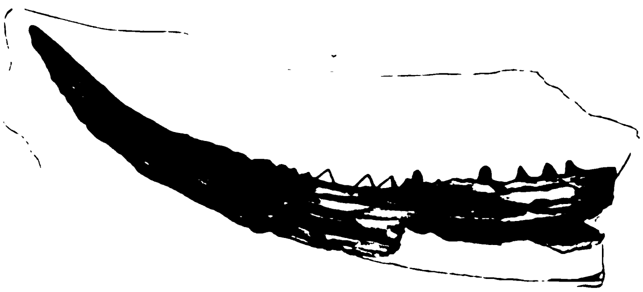
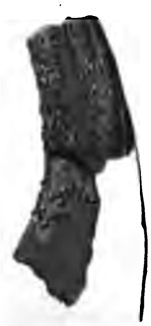
GEOLOGICAL SURVEY OF ILLINOIS

CARBONIFEROUS | FISHES

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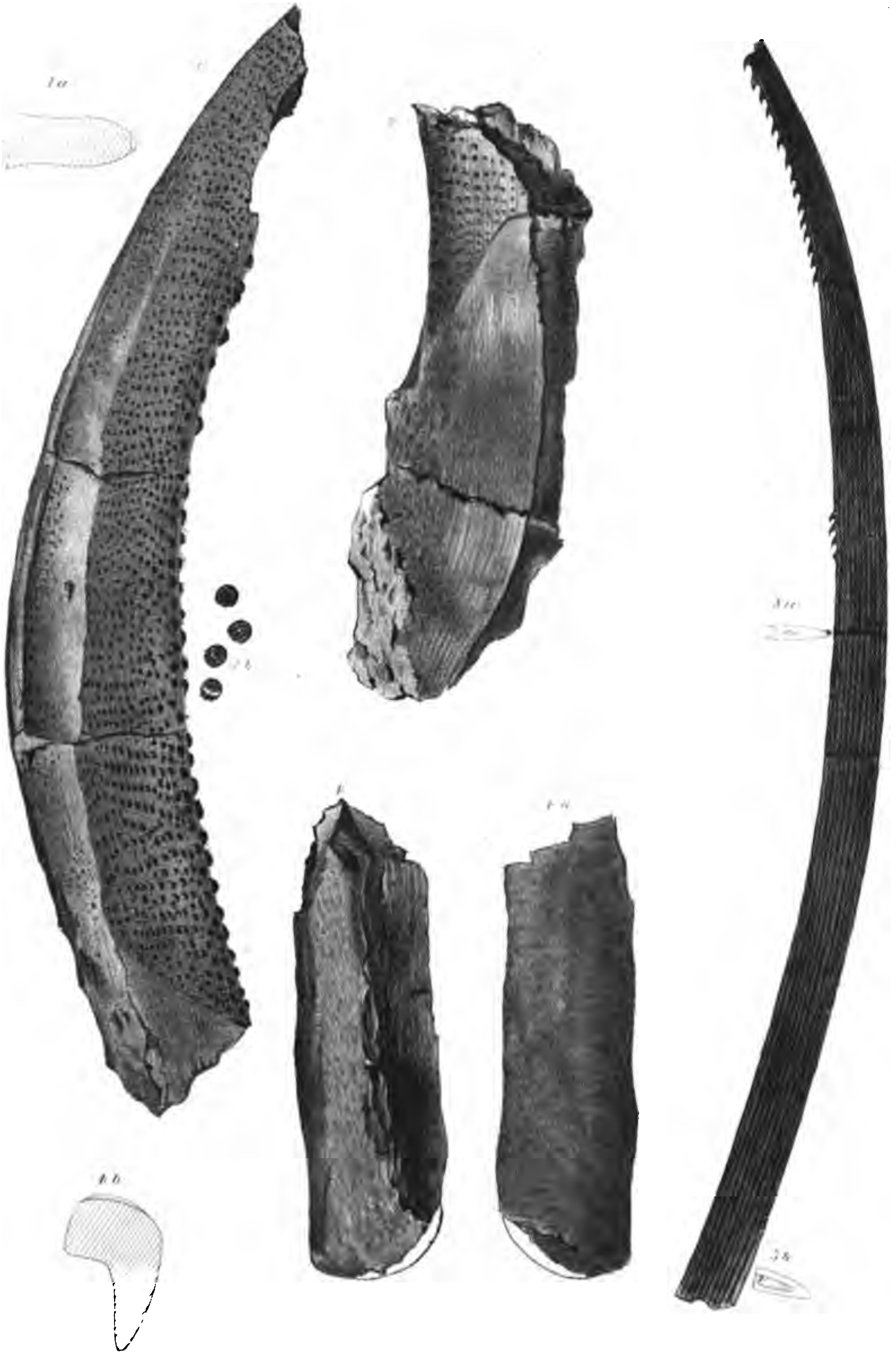
GEOLOGICAL SURVEY OF ILLINOIS.

CARBONIFEROUS. Sub Carboniferous. FISHES.



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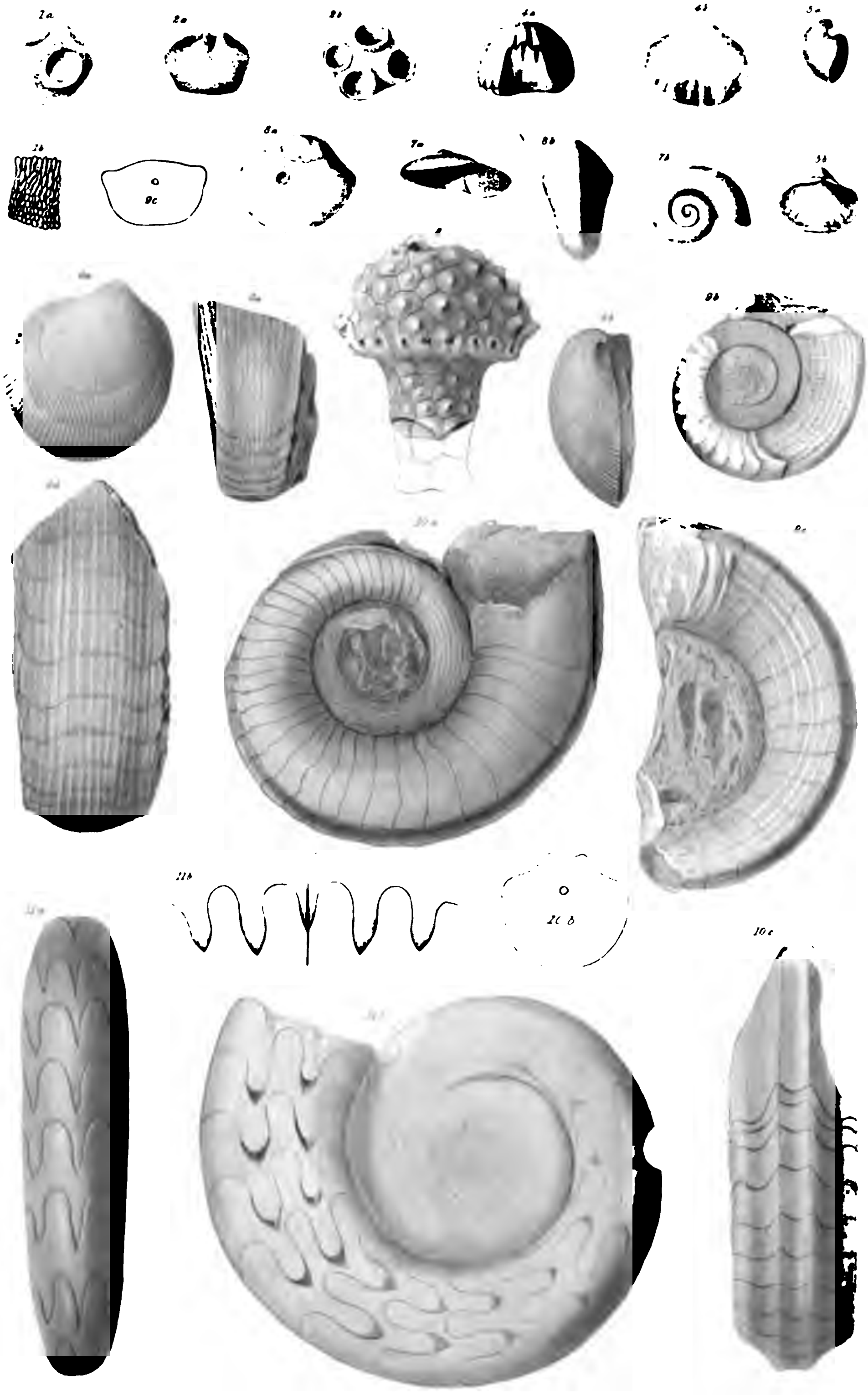
GEOLOGICAL SURVEY OF ILLINOIS

CARBONIFEROUS   (Kinderhook Group)   MISCELLANEOUS



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GEOLOGICAL SURVEY OF ILLINOIS.

CARBONIFEROUS

(Burlington Limestone)

CRINOIDEA

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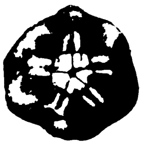

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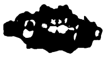

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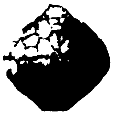

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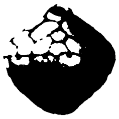

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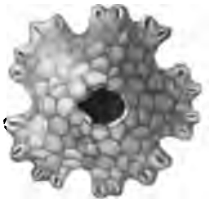

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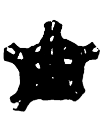

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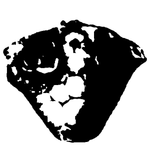

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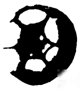

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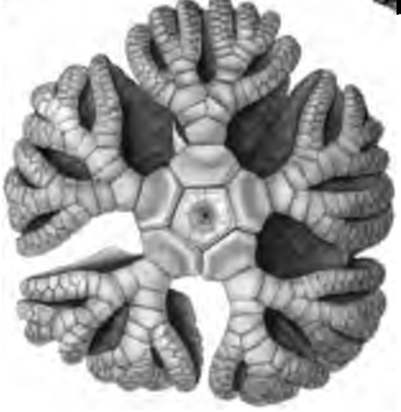

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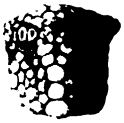

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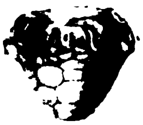

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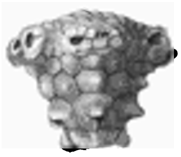

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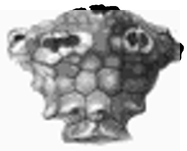

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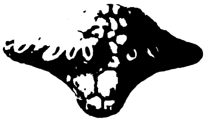

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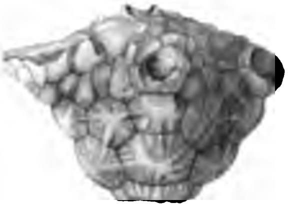

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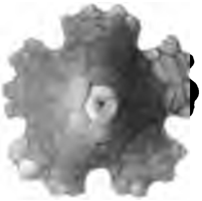

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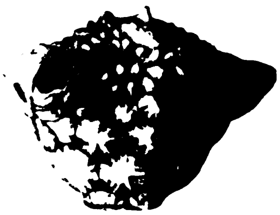

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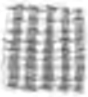

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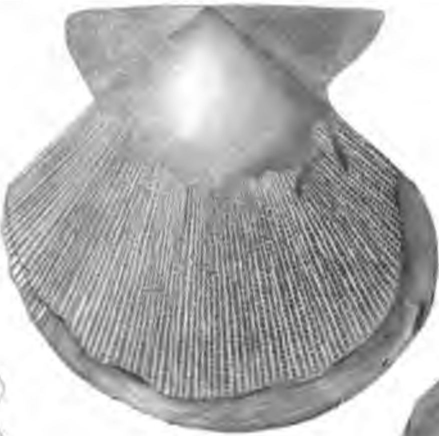

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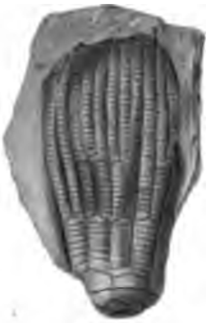

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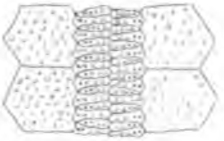

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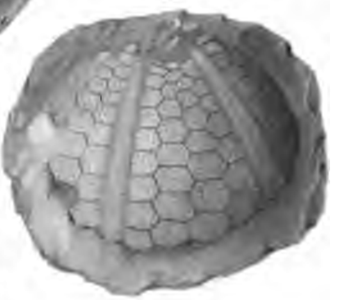

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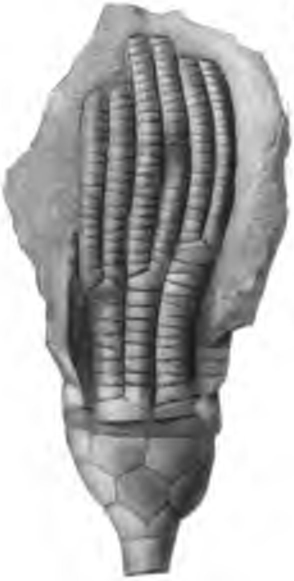

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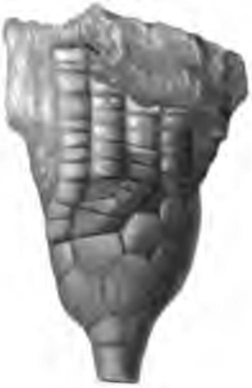

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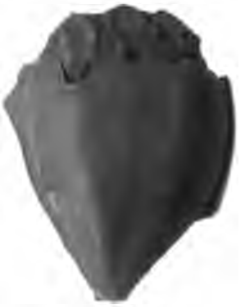

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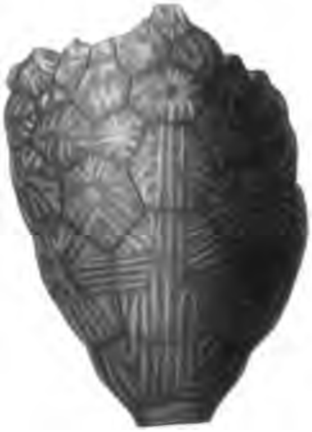

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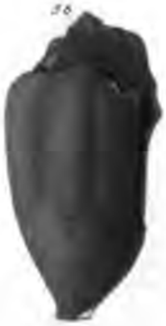

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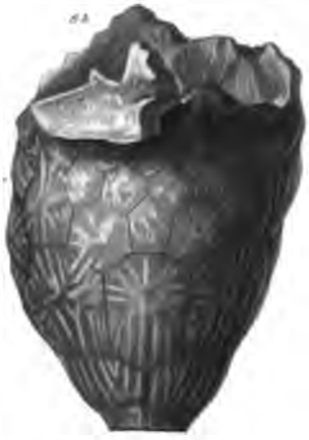

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CARBONIFEROUS Keokuk L[illegible] MISCELLANEOUS

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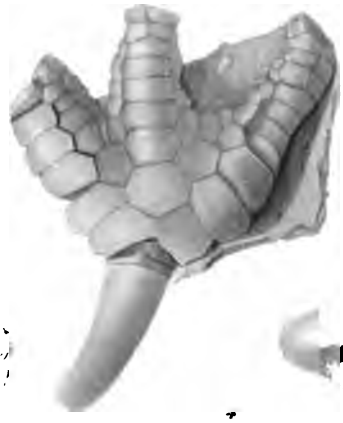

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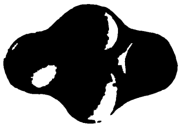

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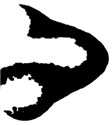

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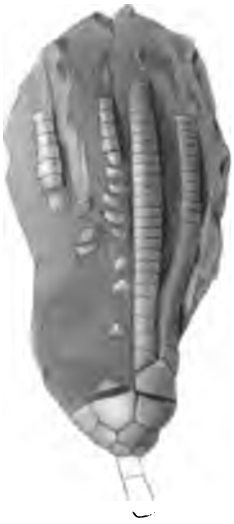

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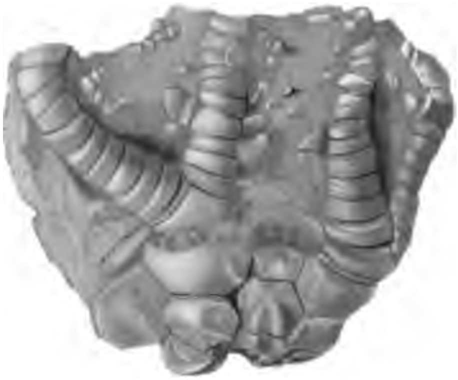

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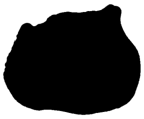

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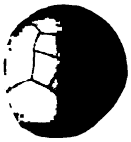

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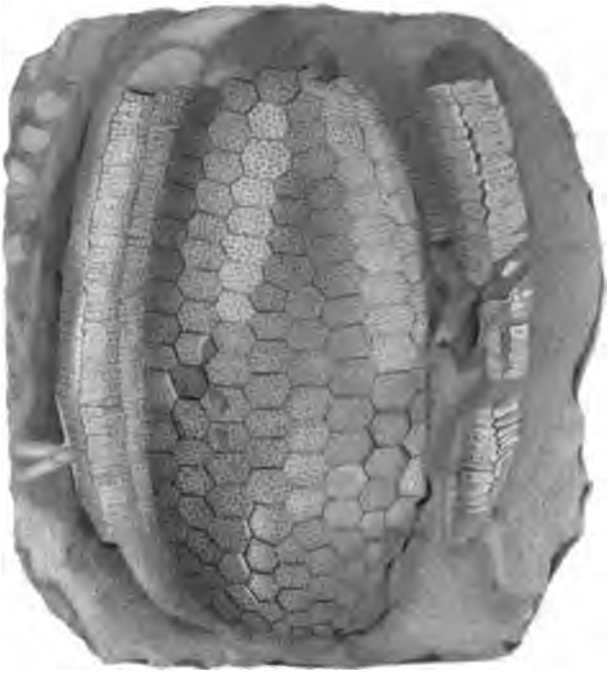

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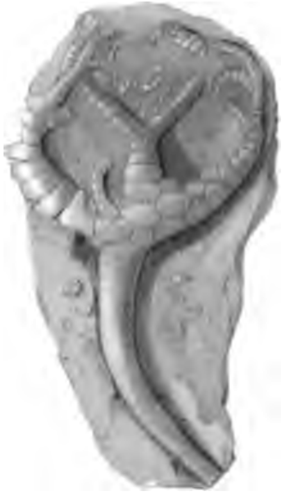

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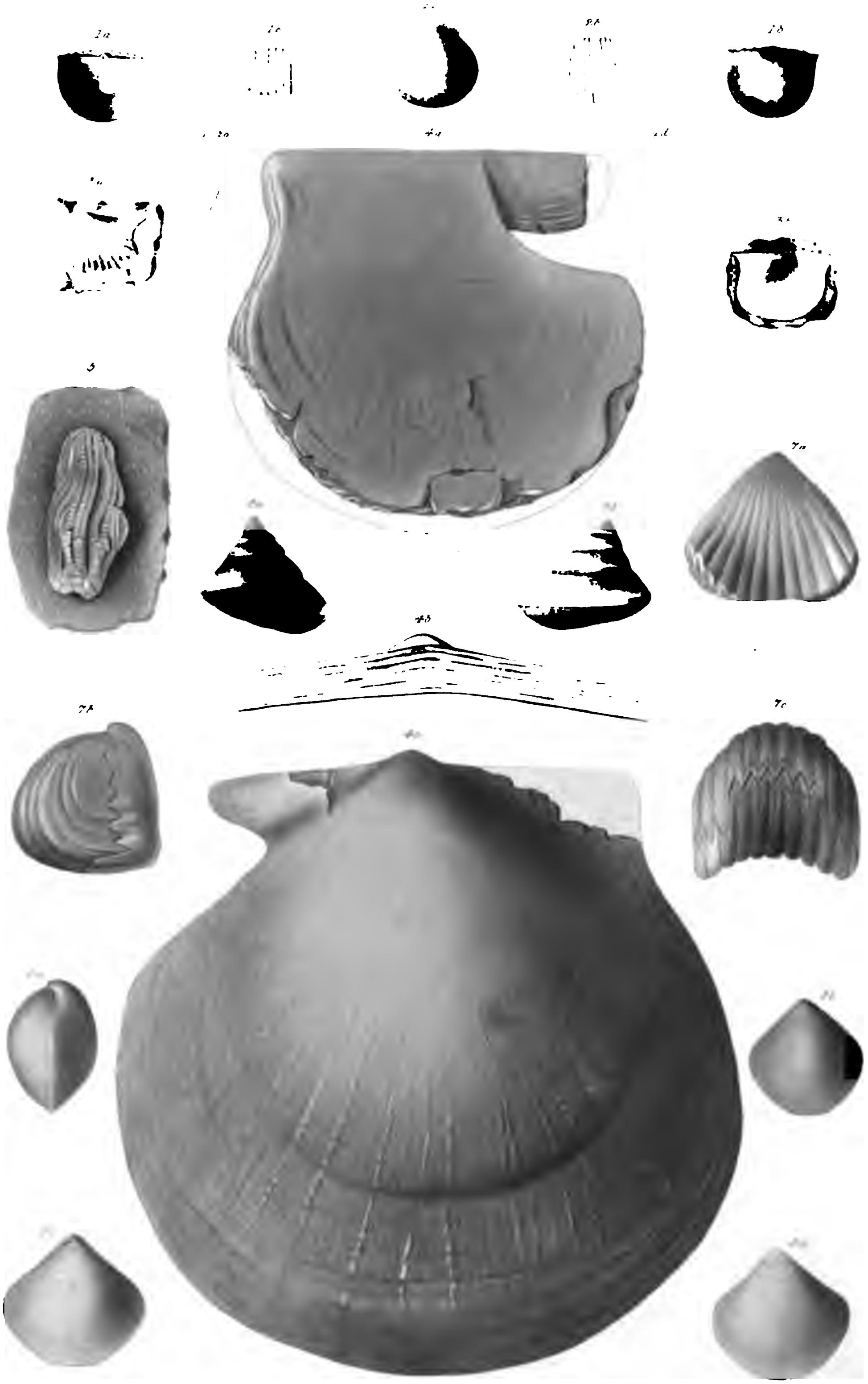
CARBONIFEROUS (Keokuk Limestone) CRINOIDEA & MOLLUSCA



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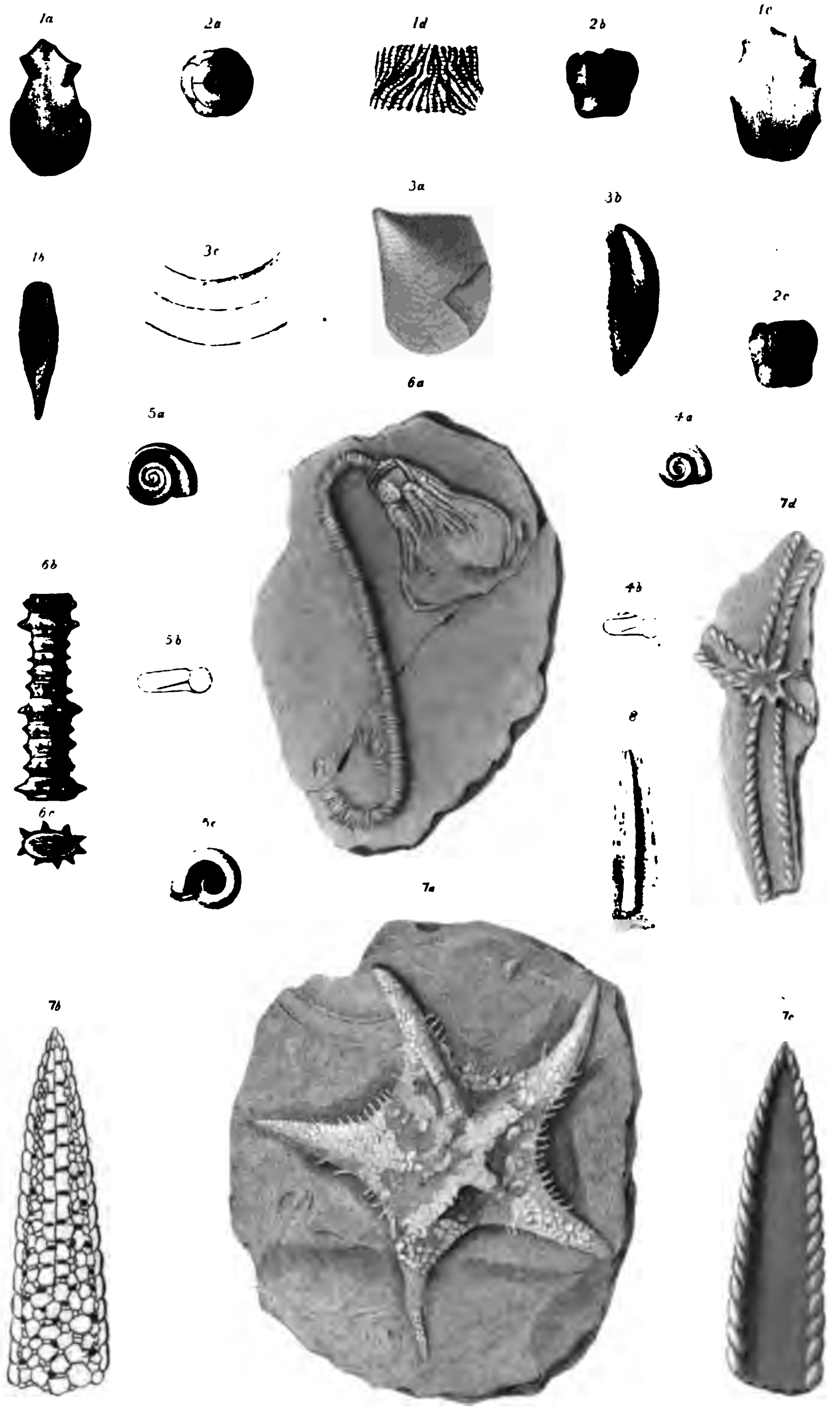
CARBONIFEROUS	Saint Louis Limestone.	MISCELLANEOUS



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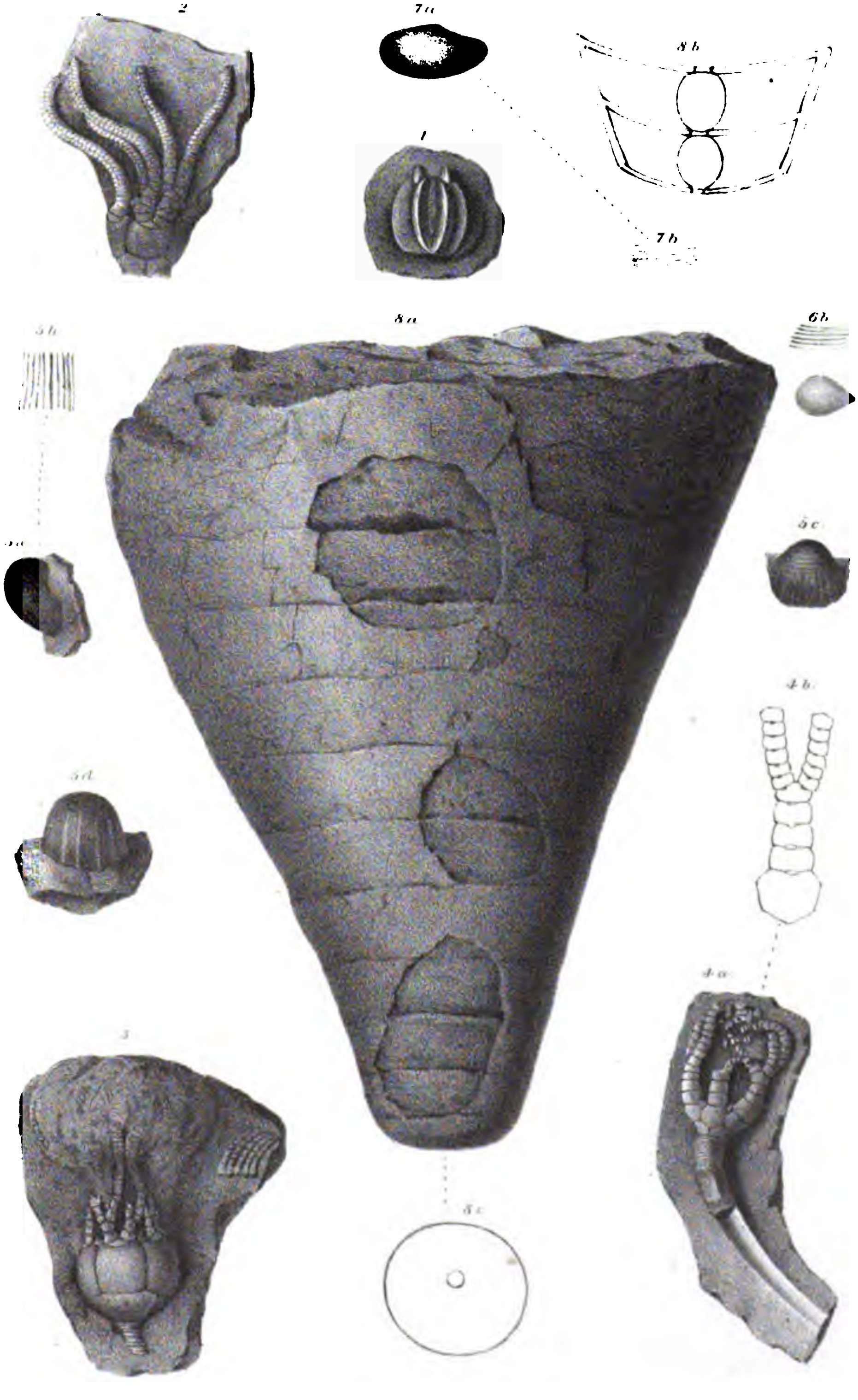
CARBONIFEROUS (St. Louis Limestone) **MISCELLANEOUS**



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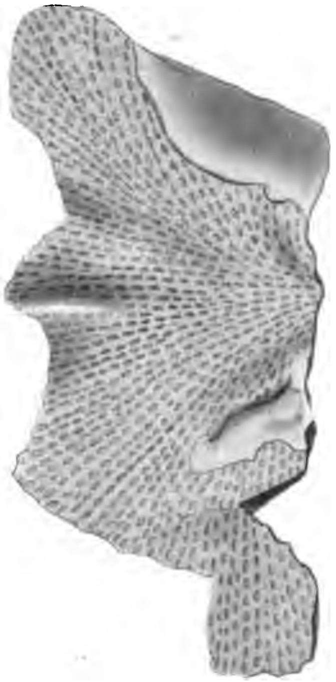

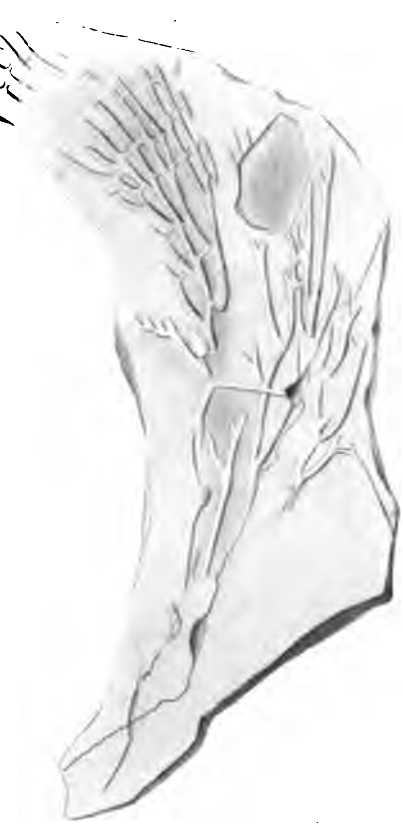

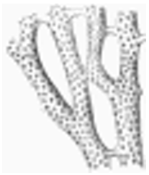

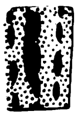

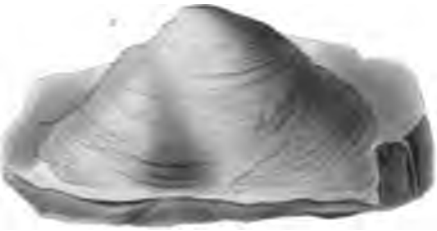

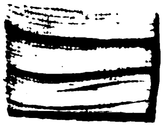

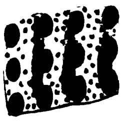

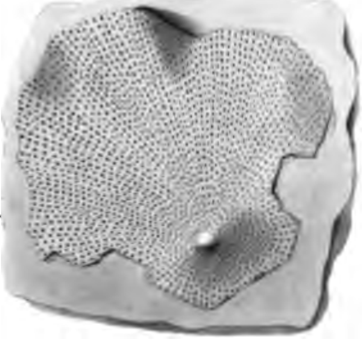

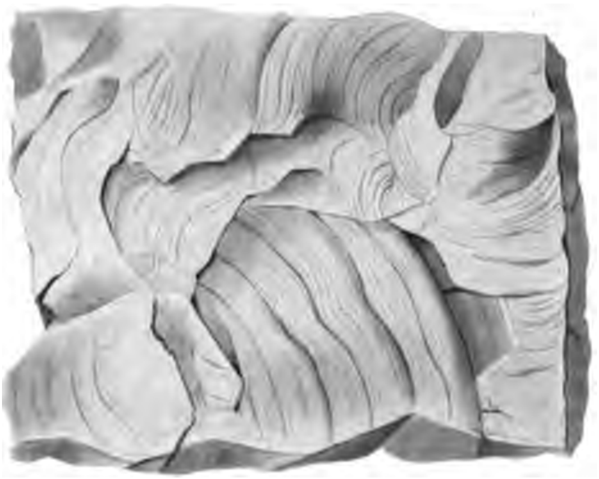

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1 *a*. Enlargement of a part of surface, so as to show one of the dimples and the pores.

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GEOLOGICAL SURVEY OF ILLINOIS

(Keokuk & St. Louis Limestone.)

CARBONIFEROUS BRYOZOA

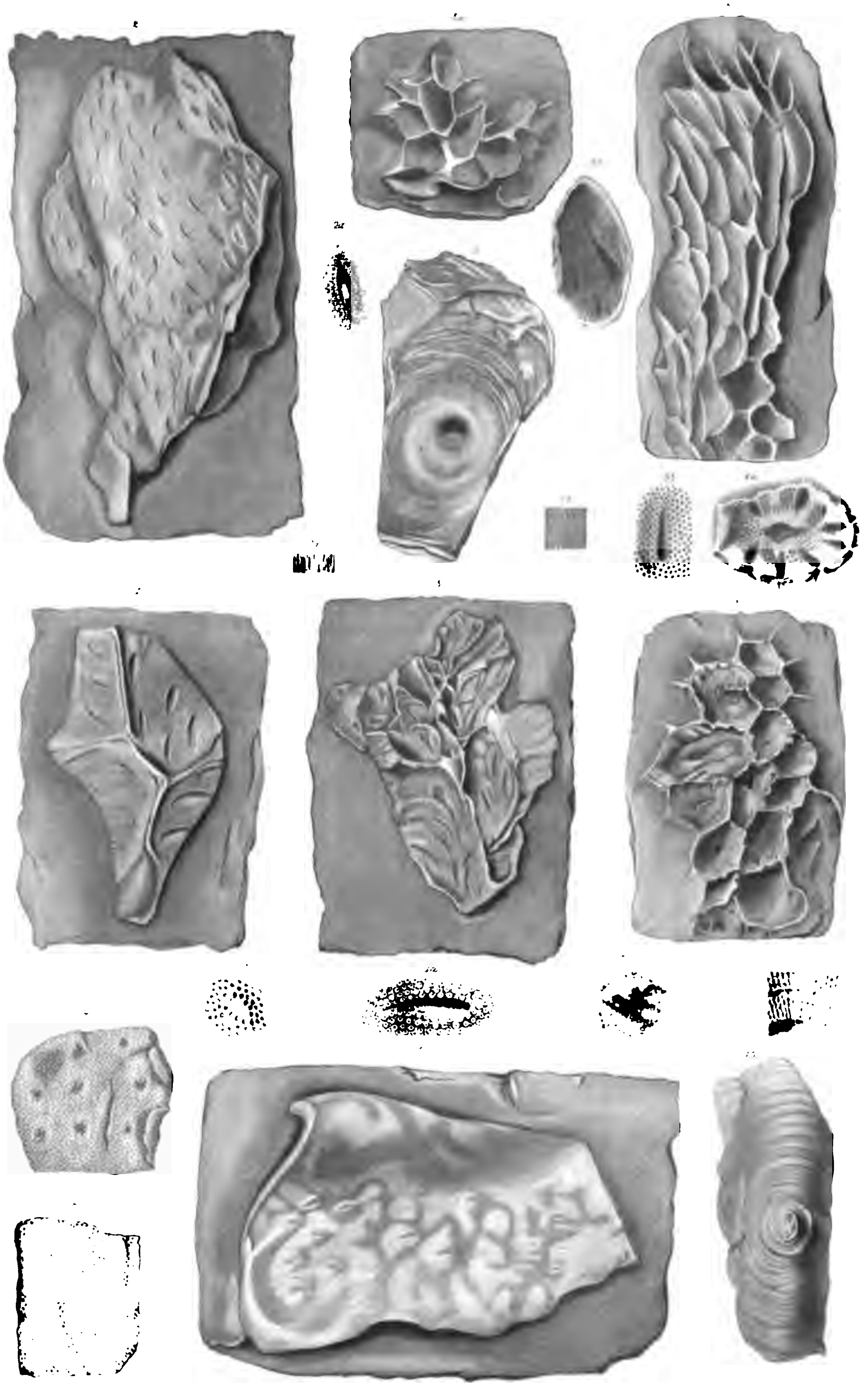

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PLATE XXIII.

PAGE

Fig. 1. **Pterotocrinus chesterensis**, M. and W. 292

1 *a*. View of a specimen with arms attached (somewhat flattened by pressure), showing base.

1 *b*. Anterior view of the body, consisting of the basal and first and second radial pieces, together with the secondary radial and first brachial pieces.

1 *c*. Anal view of the same, without the arms.

Fig. 2. **Pterotocrinus crassus**, M. and W. 290

2 *a*. Specimen with the arms attached, showing the base and posterior side.

2 *b*. Posterior side view of the body of same, without the arms.

Fig. 3. **Archæocidaris mucronatus**, M. and W. 295

3 *a*. One of the primary spines, natural size.

3 *b*. Enlargement of the fine surface striæ of the same.

3 *c*. One of the interambulacral plates.

Fig. 4. **Productus parvus**, M. and W. 297

4 *a*. Profile view.

4 *b*. Section showing the curve of the two valves.

4 *c*. View of dorsal side.

4 *d*. Ventral view.

4 *e*. Enlarged surface markings.

Fig. 5. **Spirifer glaber** *var.* **contractus**, M. and W. 298

5 *a*. Dorsal view, showing foramen and very small area.

5 *b*. Profile lateral view.

Fig. 6. **Schizodus chesterensis**, M. and W. 301

6 *a*. Anterior view of a cast, showing the anterior muscular impressions.

6 *b*. Lateral view of the same.

Fig. 7. **Myalina angulata**, M. and W. 300

7 *a*. Anterior view, showing the broad, flattened surface formed by the inflection of the anterior margins of the valves.

7 *b*. Side view.

GEOLOGICAL SURVEY OF ILLINOIS.

CARBONIFEROUS (Chester Limestone) **MISCELLANEOUS**

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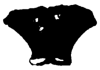

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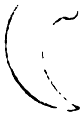

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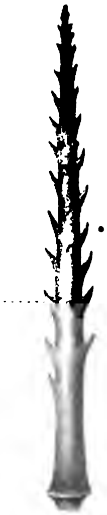

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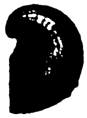

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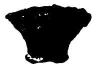

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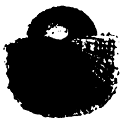

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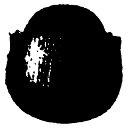

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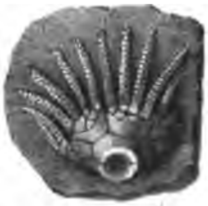

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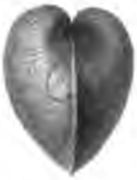

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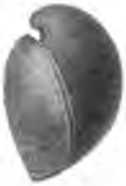

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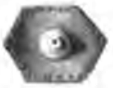

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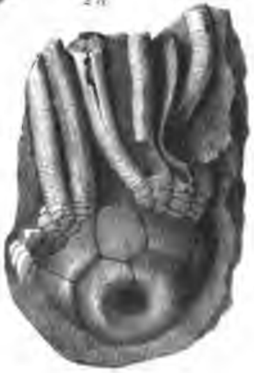

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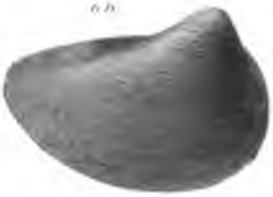

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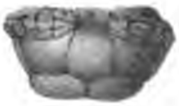

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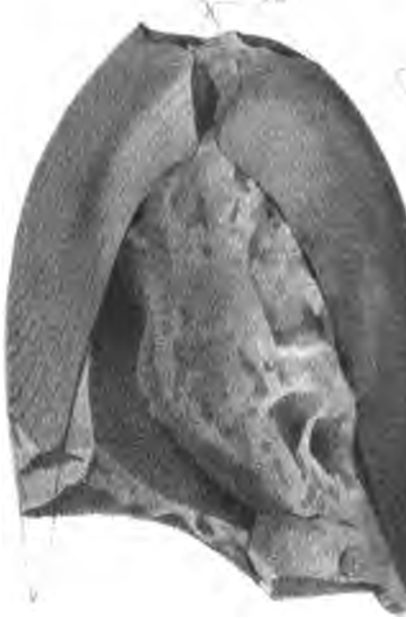

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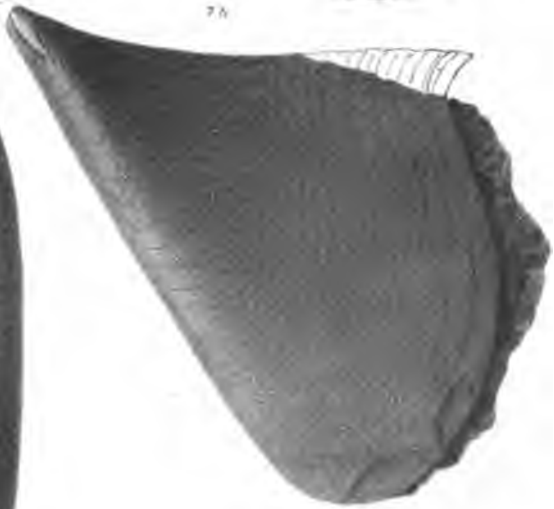

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PLATE XXIV.

PAGE

Fig. 1. **Pleurotomaria chesterensis**, M. and W. 303
- 1 *a*. Side view, showing the form of the aperture, spire, etc.
- 1 *b*. View of the opposite side.
- 1 *c*. Enlargement of surface markings.

Fig. 2. **Straparollus planodorsatus**, M. and W. 302
- 2 *a*. View of upper side.
- 2 *b*. Outline profile, showing the form of the aperture, spire, etc.
- 2 *c*. Under side of a smaller specimen, showing the umbilicus.

Fig. 3. **Orthoceras annulato-costatum**, M. and W. 304
- 3 *a*. Side view of an imperfect specimen.
- 3 *b*. Dorsal or ventral view of the same.

Fig. 4. **Nautilus chesterensis**, M. and W. 306
- 4 *a*. Dorsal view.
- 4 *b*. Side view, showing the size of the umbilicus in the cast.

Fig. 5. **Nautilus globatus**, Sowerby? 305
- 5 *a*. Lateral view, showing the size of the umbilicus in the cast.
- 5 *b*. Dorsal view, showing the outline of the lip, the sinus of which is not quite deep enough in the engraving.

GEOLOGICAL SURVEY OF ILLINOIS.

CARBONIFEROUS (Chester Limestone.) GASTEROPODA & CEPHALOPODA.

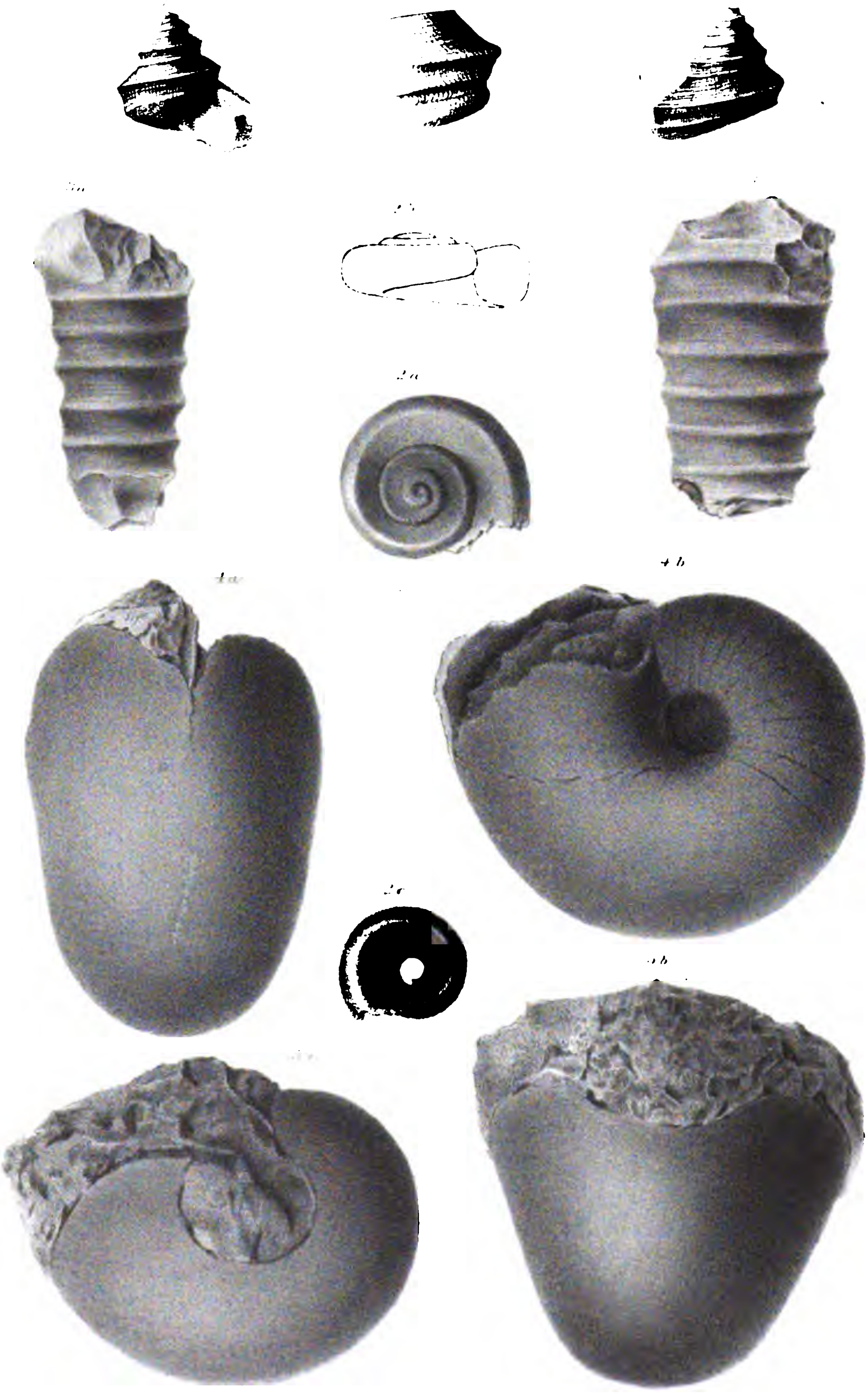

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PLATE XXV.

		PAGE
Fig. 1.	NAUTILUS SPECTABILIS, M. and W.	308
1 *a*.	**Profile view of a young specimen, or the inner whorls of an adult, showing the position of the siphuncle, etc.**	
1 *b*.	**Lateral view of same, showing the umbilicus.**	

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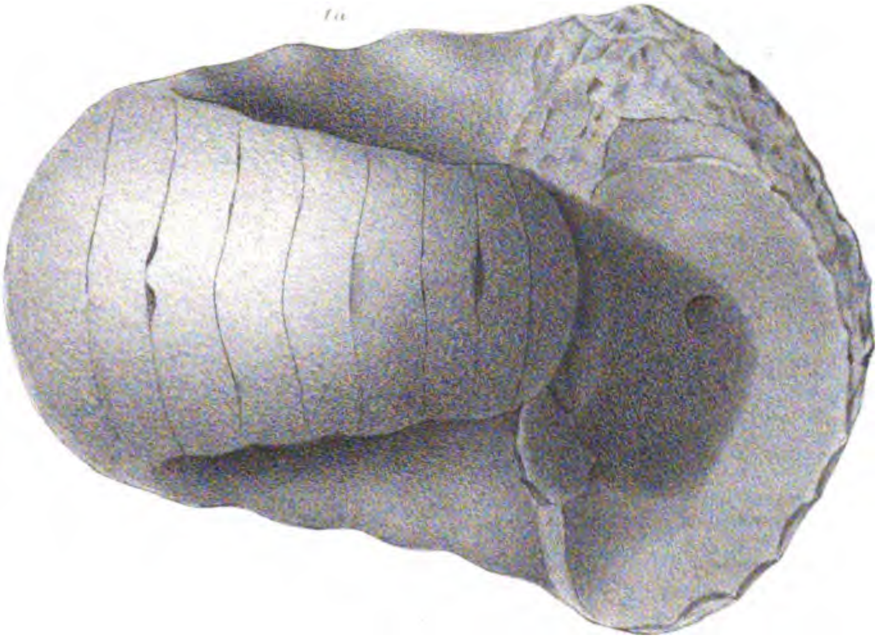
GEOLOGICAL SURVEY OF ILLINOIS.

CARBONIFEROUS. (Chester Limestone) CEPHALOPODA.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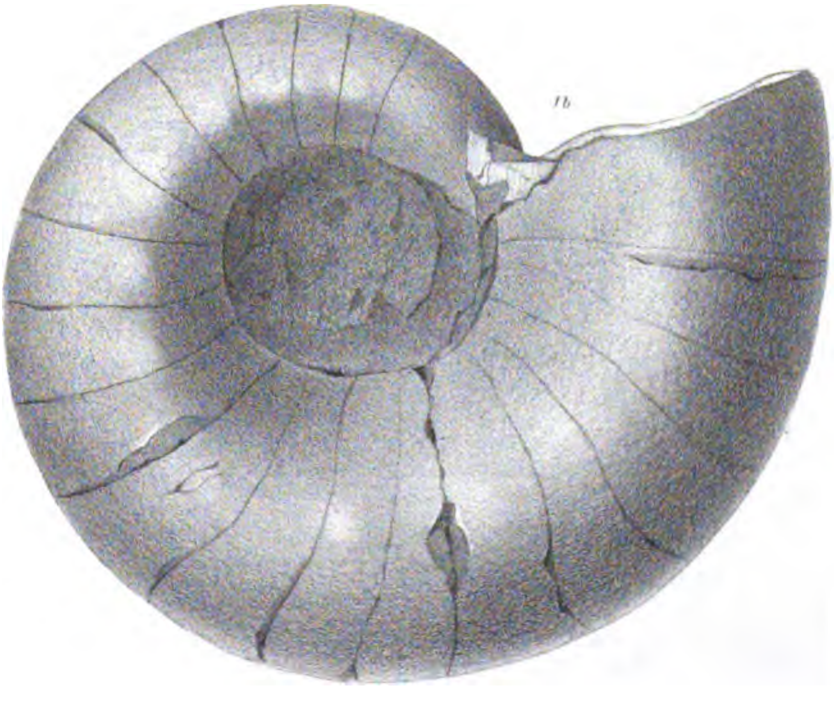
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PLATE XXVI.

PAGE

Fig. 1. Cyathocrinus? sangamonensis, M. and W. 310
1 *a.* View of anal or posterior side of the body, without the arms.
1 *b.* View of under side of same.

Fig. 2. Zeacrinus? crassus, M. and W. 314
2 *a.* Posterior view of body to the top of second radial pieces.
2 *b.* View of under side of same.

Fig. 3. Zeacrinus discus, M. and W. 312
3 *a.* Under side of body.
3 *b.* Posterior side of same to the top of first radials.

Fig. 4. Productus nanus, M. and W. 320
4 *a.* Ventral view.
4 *b.* View of front.
4 *c.* Lateral view.
4 *d.* Enlargement of costæ on front.

Fig. 5. Aviculopecten pellucidus, M. and W. 327
5 *a.* Left valve.
5 *b.* Enlarged surface markings.

Fig. 6. Aviculopecten Coxanus, M. and W. 326
6 *a.* Left valve.
6 *b.* Enlarged surface markings of same.

Fig. 7. Aviculopecten interlineatus, M. and W. 329
7 *a.* View of left valve.
6 *b.* Surface markings, enlarged.

Fig. 8. Aviculopecten Koninckii, M. and W. 328
8 *a.* View of right valve. (Costæ slightly too large and too distant, in the engraving.)

Fig. 9. Myalina recurvirostris, M. and W. 344
9 *a.* View of outside of left valve, showing the imbricating lamellæ of growth.
9 *b.* Inside of same, showing the muscular impression, cardinal area, etc.
9 *c.* Anterior view of the two valves united, showing their slightly different convexity, small byssal opening, unequal beaks, etc.

Fig. 9*. Streblopteria tenuilineatus, M. and W. 334
9 *a.* Right valve.
9 *b.* Enlargement of the very fine striæ.

Fig. 10. Solenomya radiata, M. and W. 349
10 *a.* Dorsal view.
10 *b.* Side view of partly exfoliated specimen.

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* The figures here alluded to are on the left lower corner of the plate. By an oversight, in changing figures from one plate to another, two species were numbered nine on this plate.

GEOLOGICAL SURVEY OF ILLINOIS

CARBONIFEROUS [illegible] CRINOIDEA & MOLLUSCA

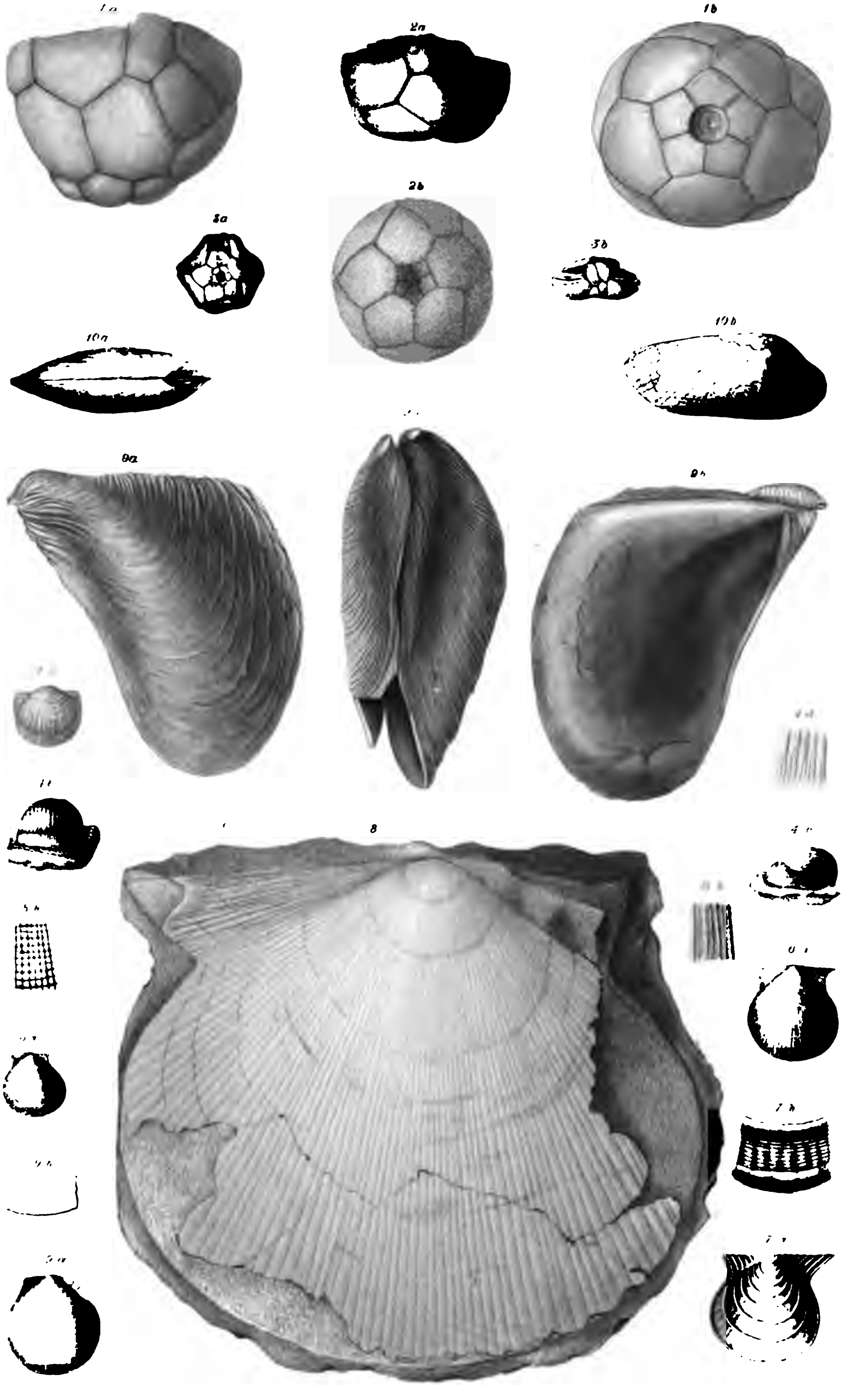

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PLATE XXVII.*

PAGE

Fig. 1. **Myalina swallovi, McC.** 341
1. Side view.
1 *a*. Dorsal view of an internal cast.
1 *b*. Dorsal view of another specimen.
1 *c*. Side view of same.
1 *d*. Surface striæ of same.

Fig. 2. **Pleurophorus subcostatus, M. and W.** 347
2. Side view of an internal cast, showing the muscular and pallial impressions, as well as the impression of the long posterior hinge tooth.
2 *a*. Dorsal view of the same.

Fig. 3. **Myalina meliniformis, M. and W.** 343
Side view of an internal cast, showing muscular and pallial impressions.

Fig. 4–5. **Aviculopecten occidentalis, Shum?** 331
4. Internal cast of a right valve, showing the muscular scar, deep byssal sinus, and the impression of the cardinal area.
5. Internal cast of left valve. (Costæ not well represented in engraving.)
5 *a*. Surface marking of left valve slightly enlarged.

Fig. 6. **Edmondia unioniformis, Phillips?** 346
6. Dorsal view of an internal cast.
6 *a*. Dorsal view of a left valve of another specimen, showing the impression of the cartilage attachment.
6 *b*. Side view of same.

Fig. 7. **Schizodus ———, (Sp?)** 345
Side view of an imperfect internal cast.

Fig. 8. **Turritella? Stevensana, M. and W.** 382
8. Side view enlarged. (Natural size shown by the line at its side.)
8 *a*. Body and succeeding whorl, considerably enlarged, to show the surface markings.

Fig. 9. **Allorisma, (Sp. undt.)** 350
9. Dorsal view of internal cast.
9 *a*. Side view of same.

Fig. 10. **Macrocheilus, (undt.)** 372
View of internal cast.

Fig. 11. **Pterinea (Monopteria) gibbosa, M. and W.** 340
11. View of internal cast left valve.
11 *a*. Anterior view of internal cast of right valve, showing the lunle.
11 *b*. Side view of the last.

Fig. 12–14. **Eumicrotis Hawni *var.* sinuata, M. and W.** 338
12. Anterior view of internal cast of a left valve.
12 *a*. Side view of same, showing the sinuous anterior margin.
12 *b*. Surface markings of left valve.
13. Internal cast of a right valve, showing the deep byssal sinus and muscular scar; also, the beak of the left valve rising above, with the cast of the cartilage pit beneath it.
14. A cast of another left valve, differing somewhat in form from fig. 12 *a*.

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* The fossils figured on this plate are placed together, because they are all associated in a bed once supposed to be probably of Permian age.

CARBONIFEROUS (Coal Measures) MOLLUSKS

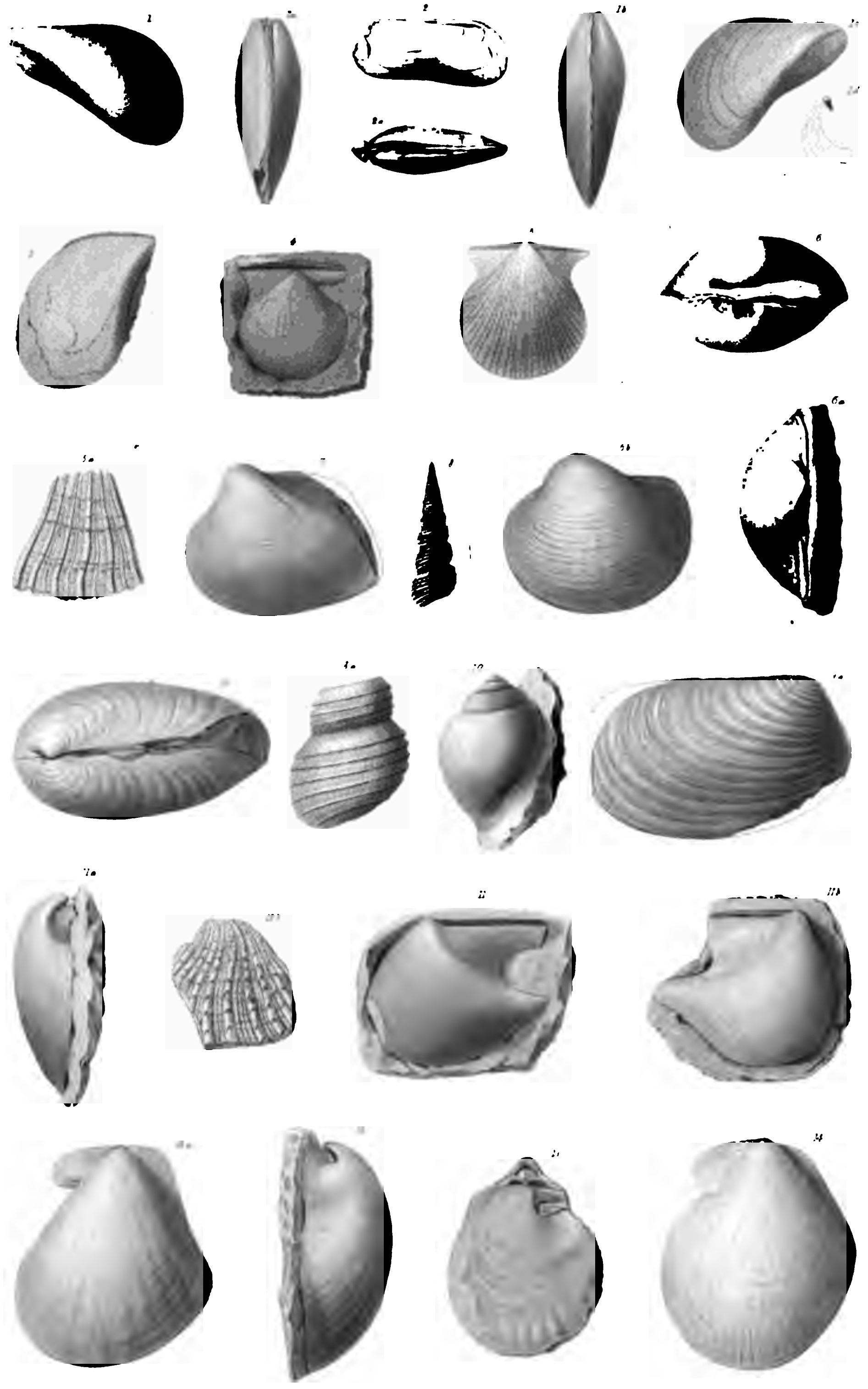

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PLATE XXVIII.

PAGE
Fig. 1. Pleurotomaria Brazoensis, Shumard?....................354
1 *a.* Side view, a little enlarged, showing aperture.
1 *b.* Opposite side of same.
1 *c.* Natural size.
1 *d.* Enlarged diagram of surface markings.
Fig. 2. Pleurotomaria granulo-striata, M. and W............356
2 *a.* Side view, enlarged, showing the aperture.
2 *b.* Opposite side of same.
2 *c.* Natural size.
2 *d.* Enlarged diagram of surface markings.
Fig. 3. Pleurotomaria tenuicincta, M. and W..................355
3 *a.* Side view, enlarged.
3 *b.* Opposite side of same, showing (imperfectly) the aperture.
3 *c.* Natural size.
3 *d.* Enlarged diagram of surface markings.
Fig. 4. Pleurotomaria subsinuata, M. and W.....................358
4 *a.* Side view, enlarged, showing the aperture.
4 *b.* View of the opposite side of the same.
4 *c.* Enlarged diagram of surface markings.
4 *d.* Natural size.
Fig. 5. Pleurotomaria speciosa, M. and W..........................352
5 *a.* Side view, natural size.
5 *b.* Opposite view of same.
5 *c.* Enlarged diagram, showing the surface markings.
Fig. 6. Pleurotomaria subconstricta, M. and W...............351
6 *a.* Side view, magnified, and showing the aperture.
6 *b.* Opposite side of same.
6 *c.* Natural size.
6 *d.* Diagram, enlarged, showing the surface markings, spiral band, etc.
Fig. 7. Pleurotomaria Pratteni, M. and W......................357
7 *a.* Side view, enlarged, showing the aperture and the sinus in the lip.
7 *b.* Opposite side.
7 *c.* Natural size.
7 *d.* Enlarged diagram of surface markings.
Fig. 8. Pleurotomaria turbiniformis, M. and W...............359
8 *a.* Side view, natural size.
8 *b.* Opposite view of same.
8 *c.* Diagram showing enlarged surface markings.
Fig. 9. Pleurotomaria scitula, M. and W.........................353
9 *a.* Side view, enlarged, showing the aperture.
9 *b.* Opposite view of same.
9 *c.* Diagram showing surface markings and spiral band.
9 *d.* Natural size.
Fig. 10.* Pleurotomaria subscalaris, M. and W..................360
10 *a.* Side view.
10 *b.* View of opposite side, both natural size.

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* The error in the numbering of the figures of this species, mentioned on p. 360 of the text, was afterwards corrected on the plate.

GEOLOGICAL SURVEY OF ILLINOIS

CARBONIFEROUS Coal Measures GASTEROPODA

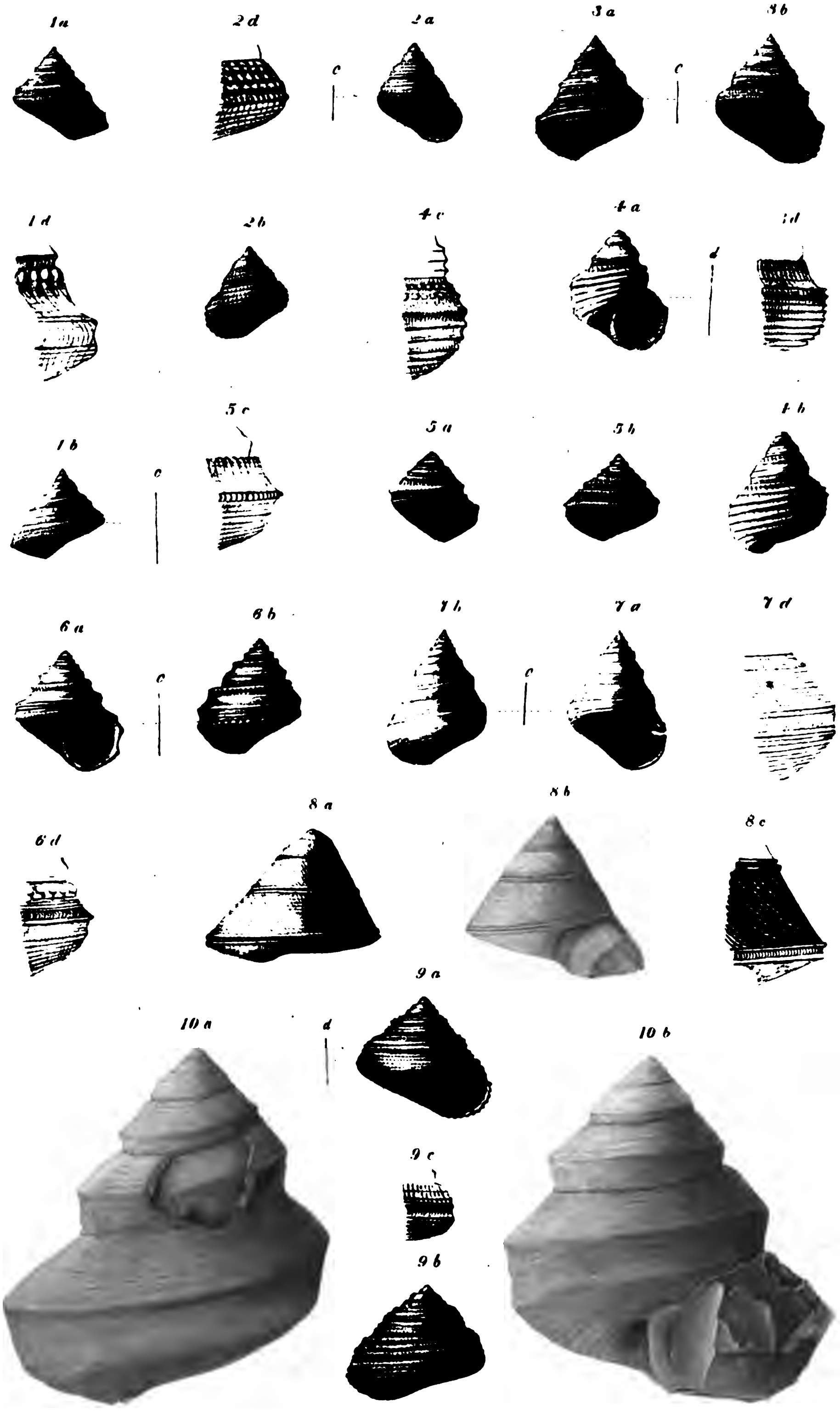

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PLATE XXIX.

PAGE

Fig. 1. **Straparollus umbilicatus, M. and W.** 362

1 *a.* View of the umbilicus and underside.

1 *b.* Side view, showing the elevation of the spire.

1 *c.* View of upper side.

Fig. 2. **Cyrtoceras? dilatatum, M. and W.** 389

A specimen imperfect at both extremities, with a portion of the shell removed so as to show the septa.

Fig. 3. **Nautilus sangamonensis, M. and W.** 386

3 *a.* Ventral side of internal cast of about half of one volution.

3 *b.* Side view of the same.

3 *c.* Section showing the outline of the whorls and the position of the siphuncle.

Fig. 4. **Nautilus planorbiformis, M. and W.** 386

4 *a.* Side view of an imperfect cast, with the external shell removed so as to show the septa.

4 *b.* Profile view, in outline, of same.

4 *c.* Section showing the outline of the outer whorl, the thickness of the shell, and the size and position of the siphuncle.

GEOLOGICAL SURVEY OF ILLINOIS.

CARBONIFEROUS. (Coal Measures.) GASTEROPODA & CEPHALOPODA

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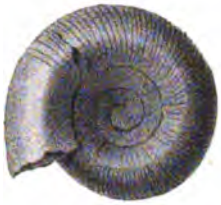

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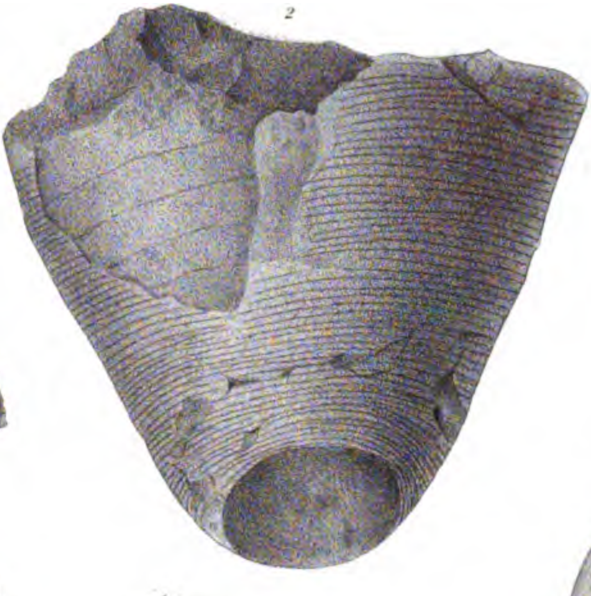

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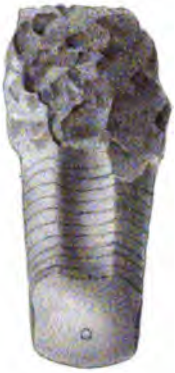

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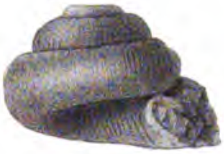

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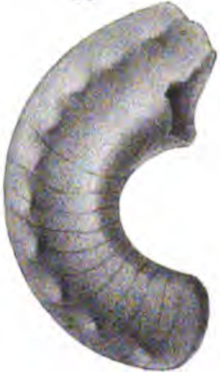

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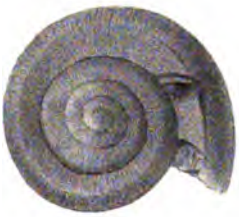

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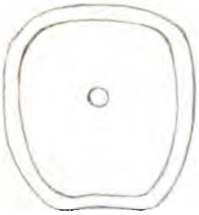

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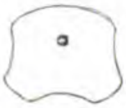

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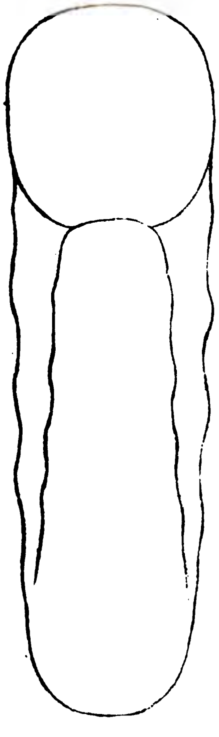

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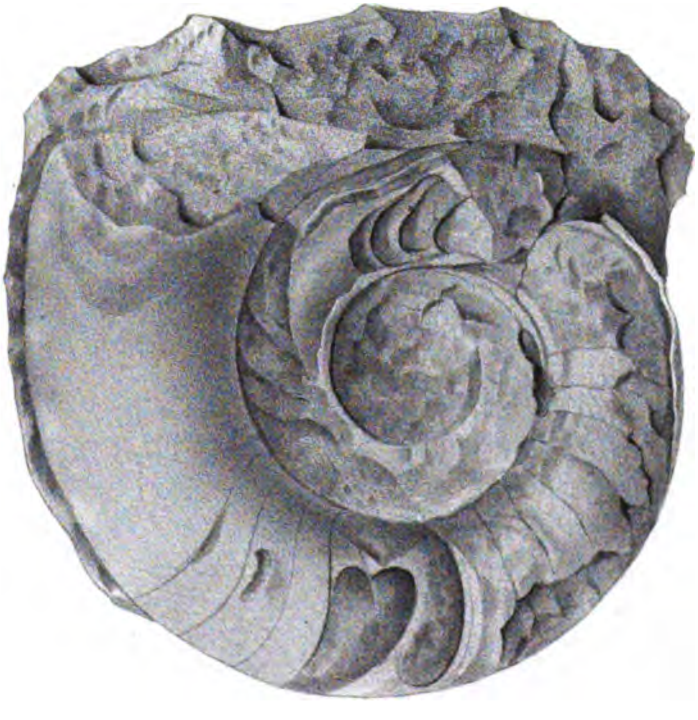

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PLATE XXX.

PAGE

Fig. 1. CYRTOCERAS CURTUM, M. and W.......... 388

1 *a.* Side view of specimen with the smaller extremity broken away, showing the arching of the surface striæ and lip, as well as the position of the siphuncle at 5.

Fig. 2. GONIATITES GLOBULOSUS, M. and W. 390

2 *a.* Dorsal side, of an internal cast, showing the septa.

2 *b.* Lateral view.

2 *c.* Diagram of one of the septa.

Fig. 3. GONIATITES IOWENSIS, M. and W......... 392

3 *a.* Side view of an internal cast, showing the septa.

3 *b.* Profile outline of same.

3 *c.* Diagram of the lobes and saddles of a septum, near natural size.

GEOLOGICAL SURVEY OF ILLINOIS.

CARBONIFEROUS. (Coal Measures.) **CEPHALOPODA.**

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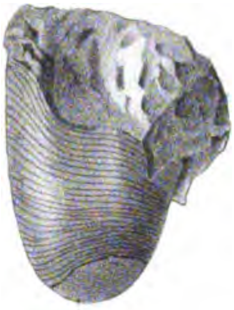

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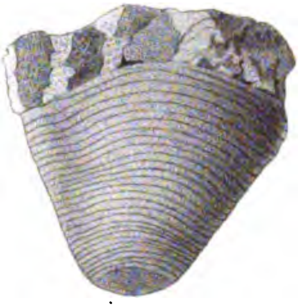

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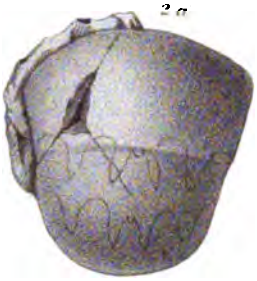

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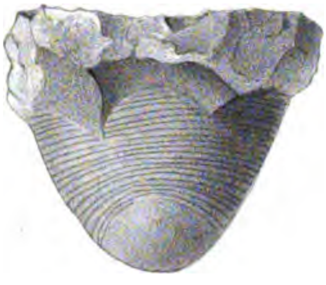

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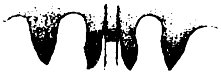

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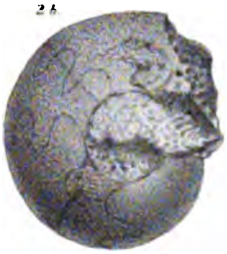

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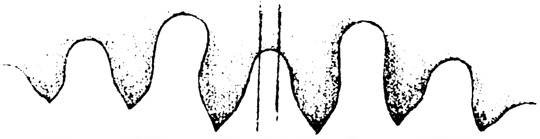

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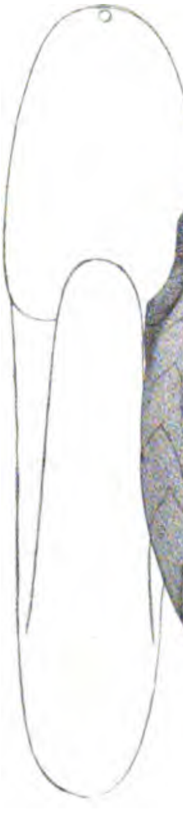

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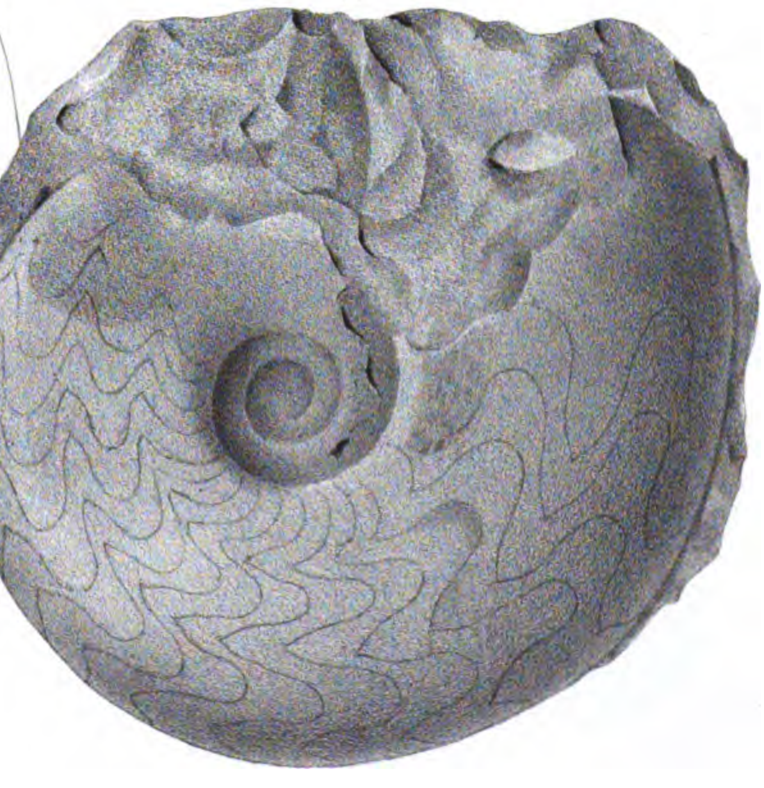

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PLATE XXXI.—CONTINUED.

PAGE

Fig. 12. LOXONEMA MULTICOSTATA, M. and W. 378

12 *a*. Magnified side view, showing the aperture.

12 *b*. Opposite side of same.

12 *c*. Natural size.

Fig. 13. LOXONEMA CERITHIFORMIS, M. and W. 379

13 *a*. Side view, showing the aperture, with lip somewhat broken.

13 *b*. View of opposite side.

13 *c*. Enlarged diagram, showing the arching of the lines of growth, and the crenulations just below the suture.

Fig. 14. ORTHONEMA SALTERI, M. and W. 381

14 *a*. Side view, enlarged, showing the aperture.

14 *b*. Opposite view.

14 *c*. Natural size.

Fig. 15. SOLENISCUS TYPICUS, M. and W. 384

15 *a*. View, natural size, showing the aperture, canal, and the fold on the columella.

15 *b*. Opposite side.

Fig. 16. BELLEROPHON CRASSUS, M. and W. 385

16 *a*. View showing the aperture, spiral band, etc.

16 *b*. Lateral view, showing the small, nearly closed umbilicus, and wrinkles of growth.

PLATE XXXI.

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Fig. 1. Pleurotomaria? tumida, M. and W. 361

1 *a*. Side view, showing the form of the aperture.

1 *b*. Opposite view.

Fig. 2. Naticopsis nodosa, M. and W. 366

2 *a*. Side view.

2 *b*. Opposite view, showing the aperture with the lip partly broken.

Fig. 3. Naticopsis nodosa *var*. Hollidayi, M. and W. 367

3 *a*. Side view, showing the aperture and flattened columella.

3 *b*. View of opposite side.

Fig. 4. Naticopsis nana, M. and W. 365

4 *a*. Side view, enlarged.

4 *b*. View of opposite side, showing the aperture, which is too much rounded within above, in the engraving.

4 *c*. Natural size.

Fig. 5. Macrocheilus medialis, M. and W. 370

5 *a*. Side view, natural size.

5 *b*. View of opposite side, showing the aperture and transverse striæ on the thickened inner lip. (The columella, and inner lip above it, are shaded so as to appear too much as if flattened on a plane.)

Fig. 6. Macrocheilus intercalaris, M. and W. 371

6 *a*. Side view, natural size.

6 *b*. View of opposite side, showing aperture.

Fig. 7. Polyphemopsis peracuta, M. and W. 375

7 *a*. Side view.

7 *b*. Opposite view, showing the aperture, with the lip broken. (The broken outer lip, which was merely restored in outline, is made to appear unnaturally thickened below, by the shading in the engraving; and the inner lip is carried too far up.)

Fig. 8. Polyphemopsis inornata, M. and W. 374

8 *a*. Side view, enlarged, showing the aperture, with the lip broken.

8 *b*. Opposite view.

8 *c*. Natural size.

Fig. 9. Polyphemopsis nitidula, M. and W. 374

9 *a*. Side view, showing the aperture, with lip broken.

9 *b*. View of opposite side.

Fig. 10. Loxonema scitula, M. and W. 377

10 *a*. Side view, enlarged, showing the aperture.

10 *b*. View of opposite side.

10 *c*. Natural size.

Fig. 11. Loxonema rugosa, M. and W. 178

11 *a*. Enlarged side view.

11 *b*. Opposite side of same, showing aperture, with lip somewhat broken.

11 *c*. Natural size.

GEOLOGICAL SURVEY OF ILLINOIS

CARBONIFEROUS ([illegible]) GASTEROPODA

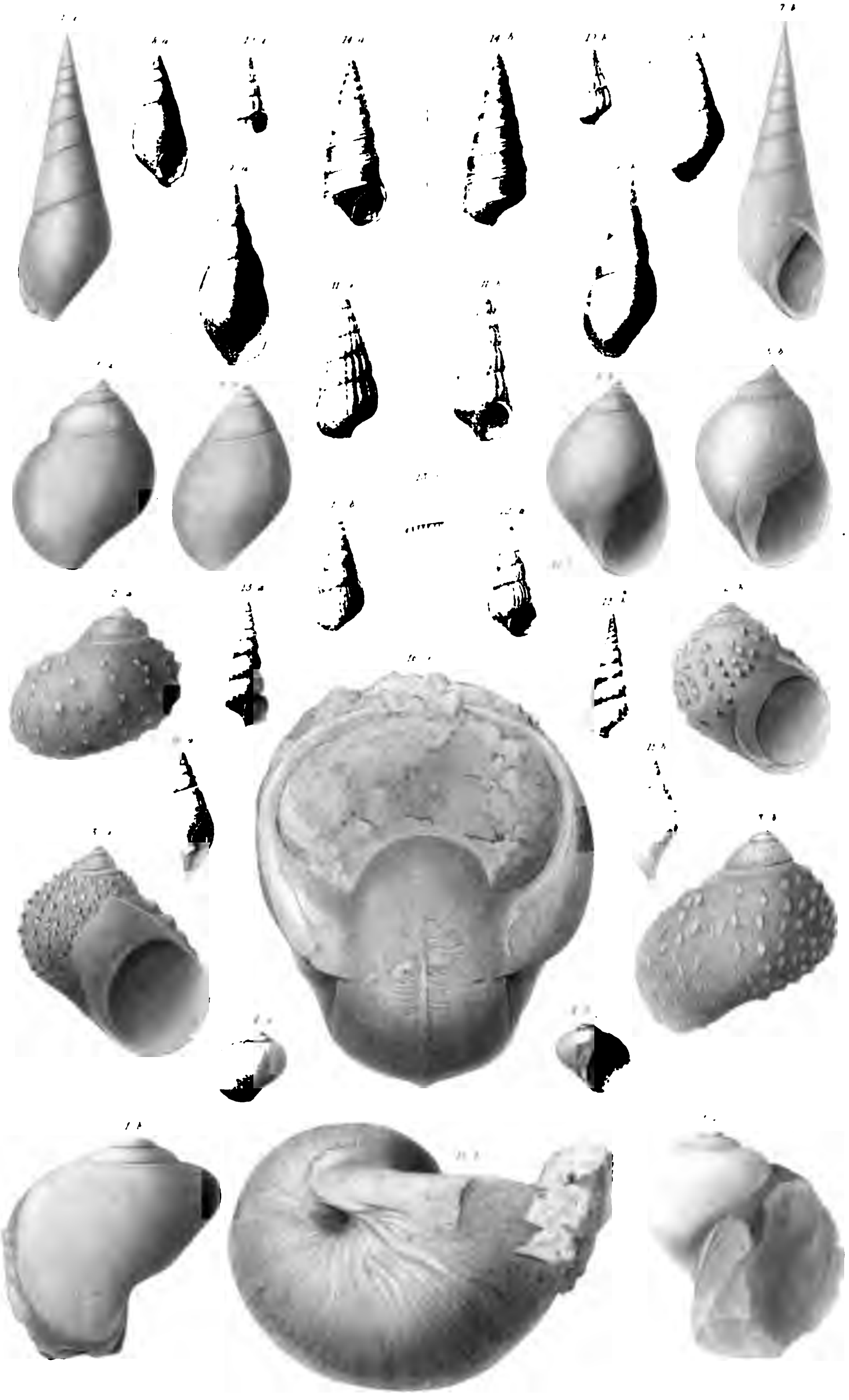

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PLATE XXXII.

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Fig. 1. Anthracerps typus, M. and W. 409

1. View of an impression of the fossil left in a concretion; natural size.

1 *a*. An enlargement of the same.

Fig. 2. Bellinurus Danæ, M. and W. 395

2. View of an internal cast of a nearly entire specimen, with the telson and some of the posterior margin restored.

2 *a*. An outline profile view of the same, in which the projecting appendages of the posterior side of the cephalo-thorax, and of the sixth segment of the thorax, are also restored in dotted lines.

Fig. 3. Palæocampa anthrax, M. and W. 410

View of the fossil, natural size, as seen in a split concretion.

Fig. 4. Anthrapalæmon gracilis, M. and W. 407

4. View of an impression, and some remaining parts of the fossil, as seen in a concretion, the caudal appendages being restored in outline.

4 *a*. Enlarged outline, to show the serrations of the anterior lateral margins of the carapace.

4 *b*. An enlargement of the three joints of the peduncle, and a portion of the flagellum, of one of the antennæ.

4 *c*. A portion of the flagellum, considerably enlarged, to show its minute segments.

Fig. 5. Palæocaris typus, M. and W. 405

5. View of a nearly entire specimen, with the telson and stylets restored.

5 *a*. Another specimen, consisting of the body and caudal appendages without the legs and head.

5 *b*. One of the small natatory abdominal appendages from fig. 5, enlarged.

5 *c*. Telson (incomplete at the extremity) enlarged so as to show the minute marginal sitæ.

5 *d*. Enlarged outline of the telson, stylets, and two of the abdominal segments—from 5 *a*.

Fig 6. Acanthotelson Stimpsoni, M. and W. 401

6. A side view of a nearly entire specimen, as seen lying in the concretion. It wants the antennæ, some portions of the legs, and the natatory abdominal appendages, and shows but one division of one of the stylets, with the similarly formed telson above.

6 *a*. Another specimen, showing the antennæ.

6 *b*. Outline restoration of the telson, stylets and two of the abdominal segments, as they must appear if the second or last joints of the stylets are not double. (Enlarged about 2 diameters.)

6 *c*. Another restoration of the same parts, as they must appear if the last joints of the stylets are double, as we have reason to believe is the case.

6 *d*. One of the thoracic legs, enlarged in outline, as it appears to be, though its extremity may not be complete.

6 *e*. Enlarged outline of one of the anterior legs, showing the setæ on two of the joints. The last joint of this leg *appears* to terminate in a pointed dactylus, but this may not be the case.

6 *f*. The telson, still farther enlarged, to show the two sets of marginal setæ.

Fig. 7. Acanthotelson inæqualis, M. and W. 403

View of specimen showing the head, antennæ and body, with fragments of the legs, but wanting the stylets and a portion of the telson.

Fig. 8. Amphibamus grandiceps, Cope................................135

Representing a nearly entire skeleton, as seen in the half of a concretion; enlarged 2 diameters.

GEOLOGICAL SURVEY OF ILLINOIS

CARBONIFEROUS (Coal Measures) MISCELLANEOUS

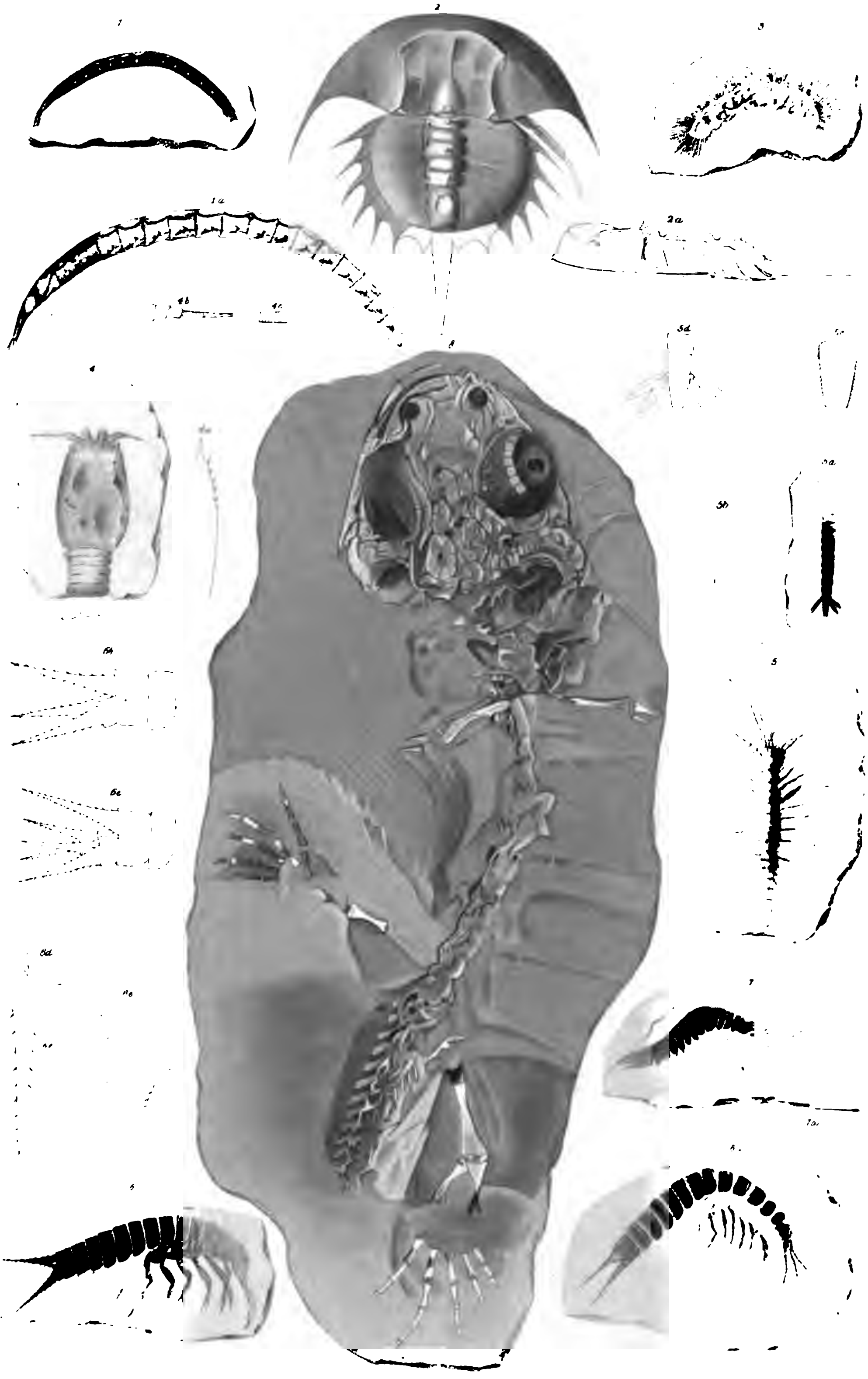

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PLATE XXXIII.

PAGE

Fig. 1–5. **NEUROPTERIS RARINERVIS**, Bunb......... 428

1 *a*, 1 *b*. Enlarged leaflets of the same, showing nervation.

2. Branch of the same, with a terminal pinnule.

3, 4, 5. Large leaflets of the same species, formerly placed in the genus *Cyclopteris* or *Nephropteris*.

4 *a*. Veinlets of the same, enlarged

GEOLOGICAL SURVEY OF ILLINOIS

CARBONIFEROUS [illegible] FOSSIL FLORA

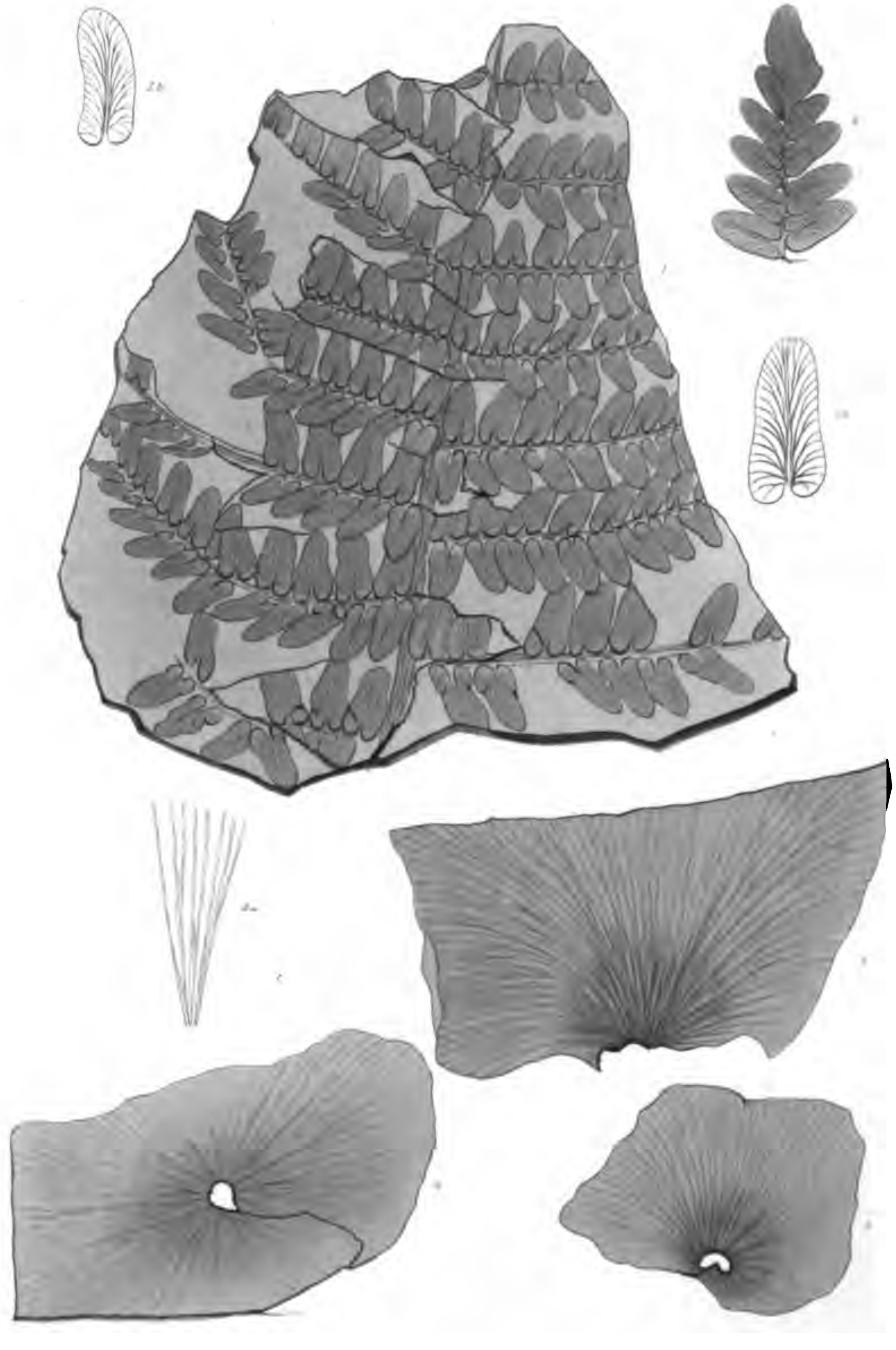

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PLATE XXXIV.

PAGE

Fig. 1. **NEUROPTERIS RARINERVIS**, Bunb.................................428

A variety with close veins and narrow leaflets.

1 *a*. Enlarged leaflet of the same, showing nervation.

Fig. 2. **HYMENOPHYLLITES PINNATIFIDUS**, Spec. nov...............436

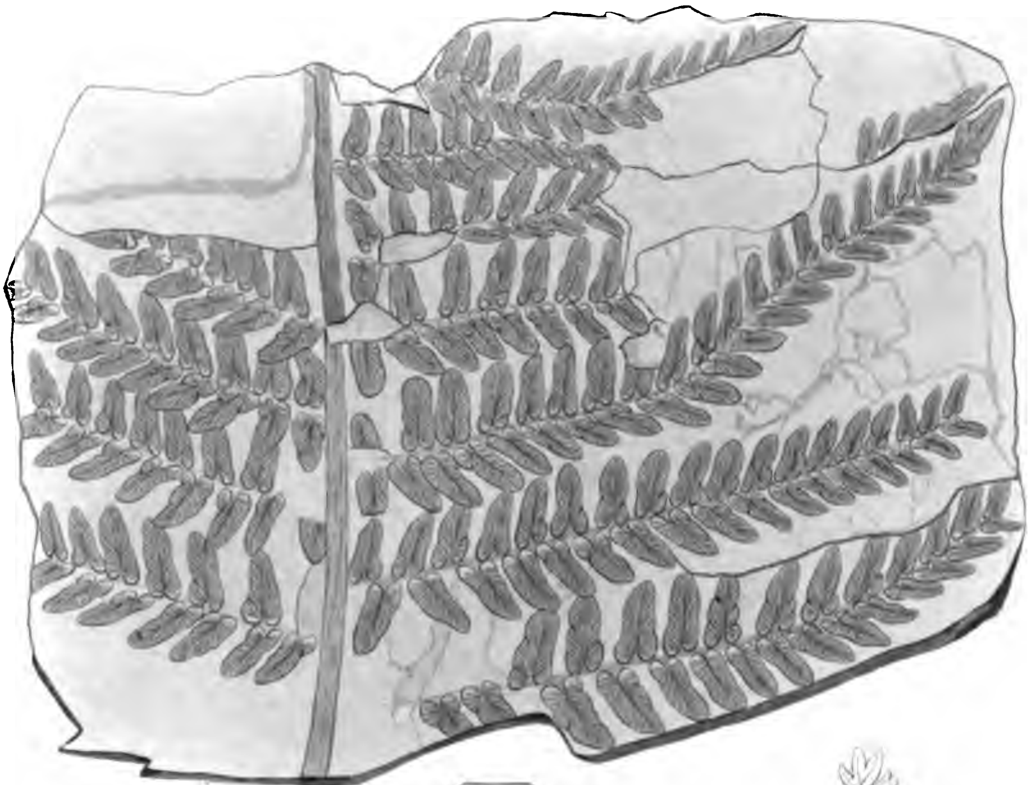
2 *a*. Enlarged leaflet of the same, showing nervation.

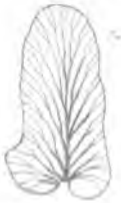
Fig. 3. **HYMENOPHYLLITES SPINOSUS**, Gopp................................436

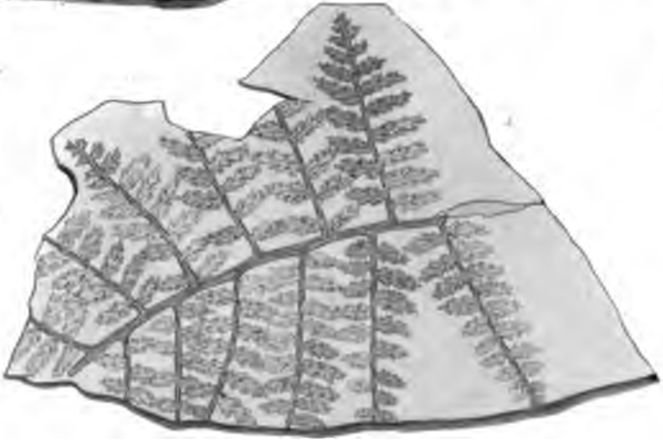
3 *a*. Enlarged leaflet of the same, showing nervation.

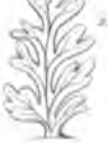
GEOLOGICAL SURVEY OF ILLINOIS

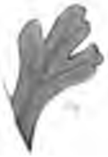
CARBONIFEROUS (Coal Measures) **FOSSIL FLORA**

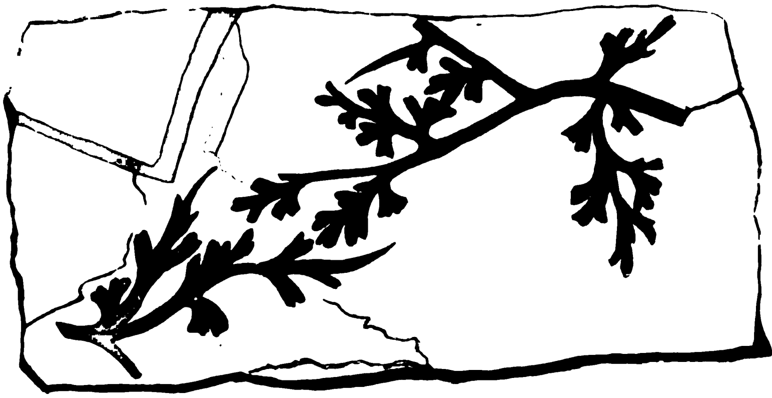












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	Branches or pinnæ.	
1 *a*, 2 *a*.	Enlarged leaflets of the same, showing nervation.	
Fig. 6–10.	**Neuropteris hirsuta**, Lsqx	427
6.	A small leaflet.	
7.	Leaflet of the same species, palmately divided.	
8, 9, 10.	Large leaflets (*Cyclopteris*) of same species.	

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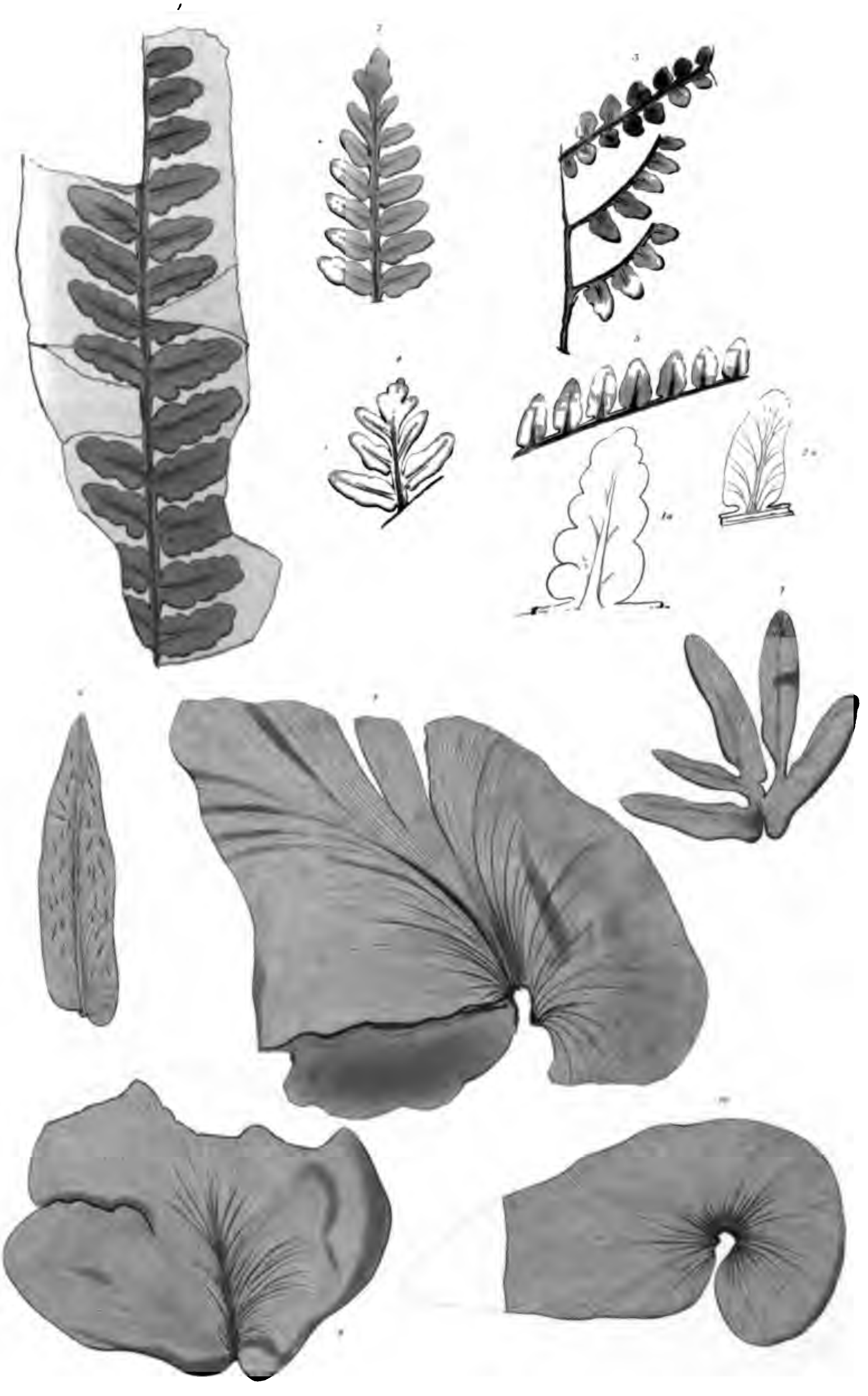

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1 *b*.	Enlarged leaflet of the same, showing nervation.	
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Fig. 5.	**Neuropteris pachyderma**, Spec. nov	430
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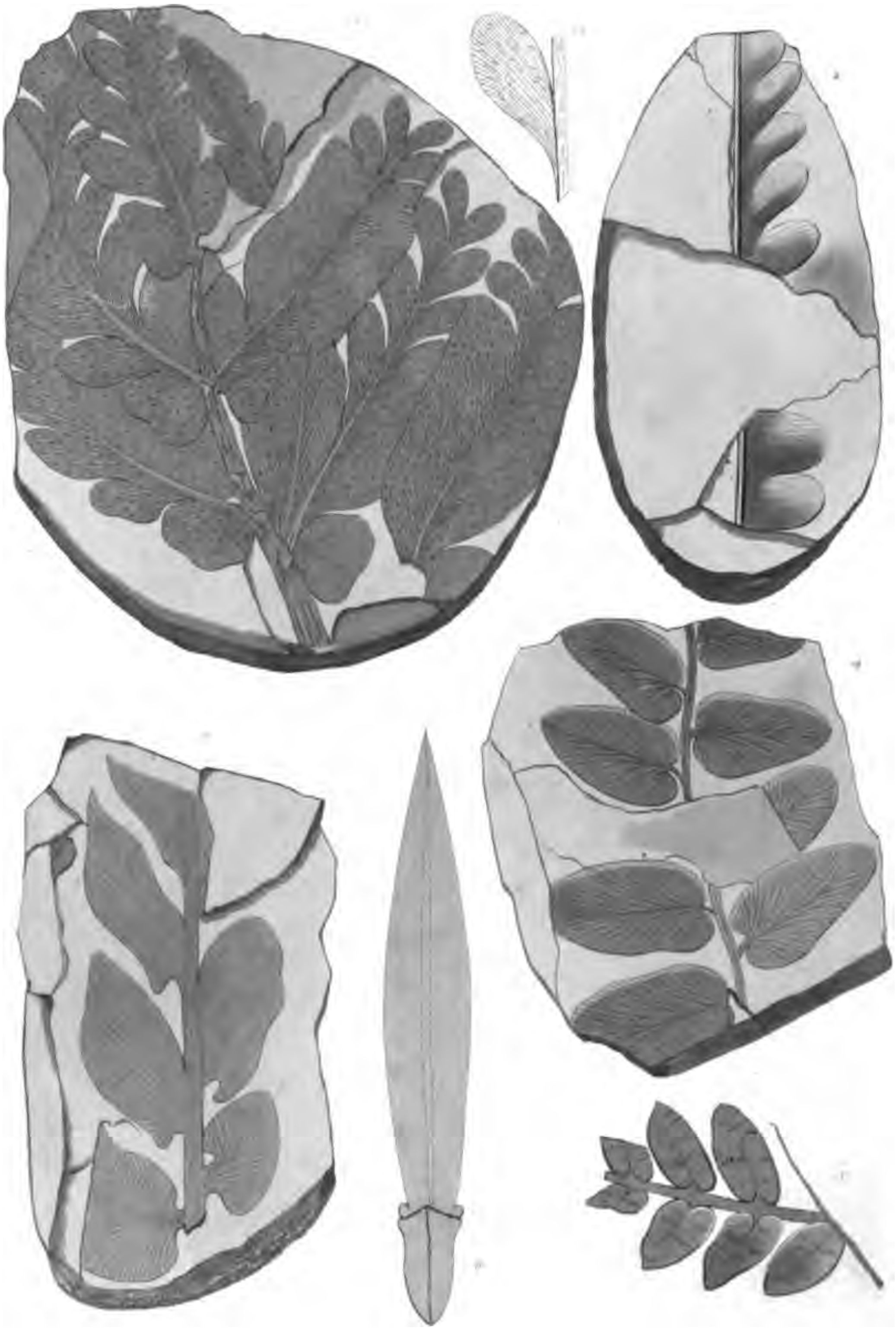

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Fig. 4.	**ALETHOPTERIS STELLATA**, Spec. nov	440
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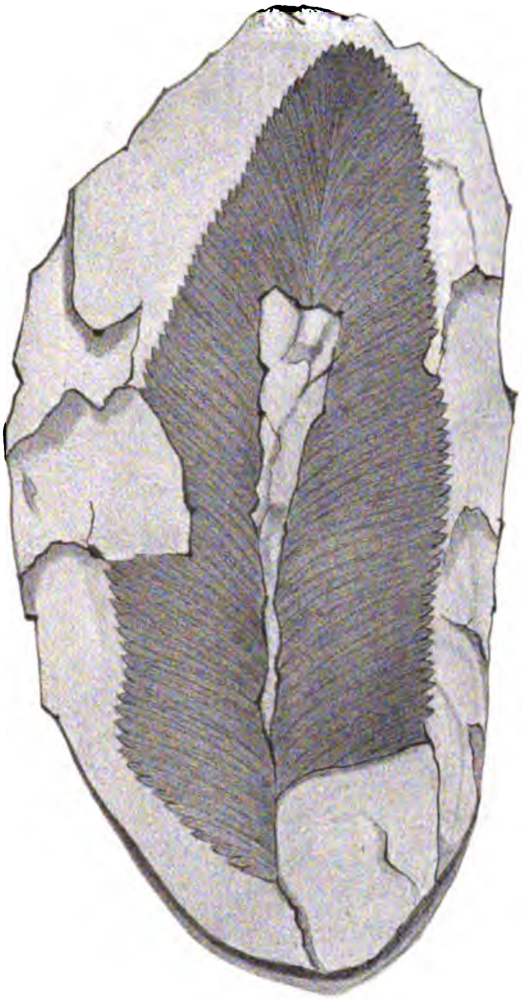

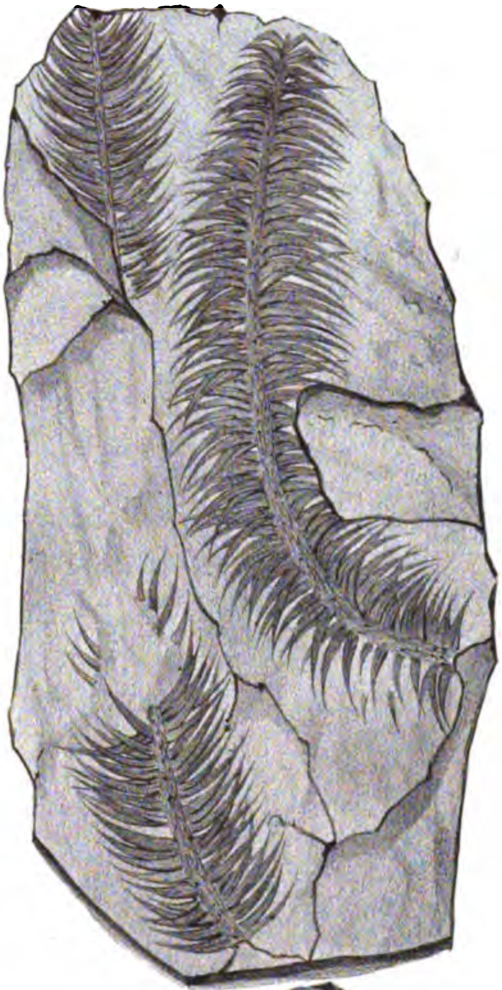

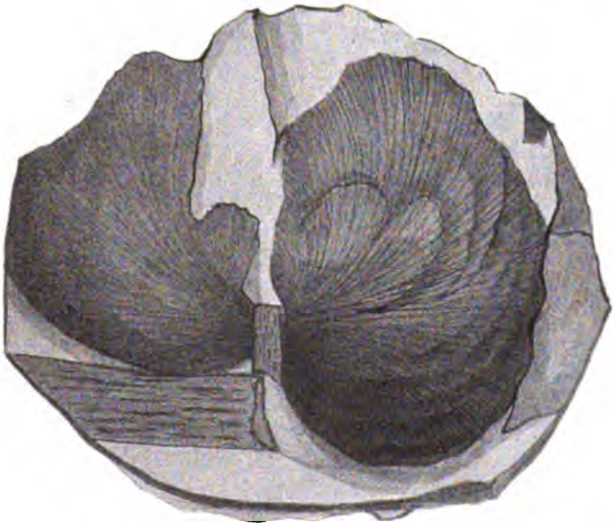

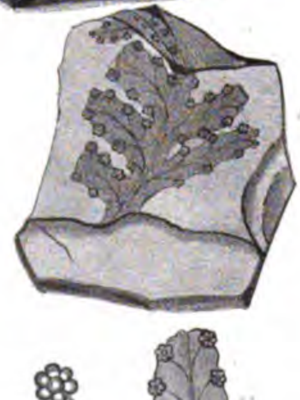

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PLATE XXXVIII.

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Fig 1.	CALLIPTERIS SULLIVANTI, Lsqx., with GYROMICES AMMONIS, Gopp	440
1 *a*.	Leaflet of *Callipteris sullivantii*, enlarged to show nervation.	
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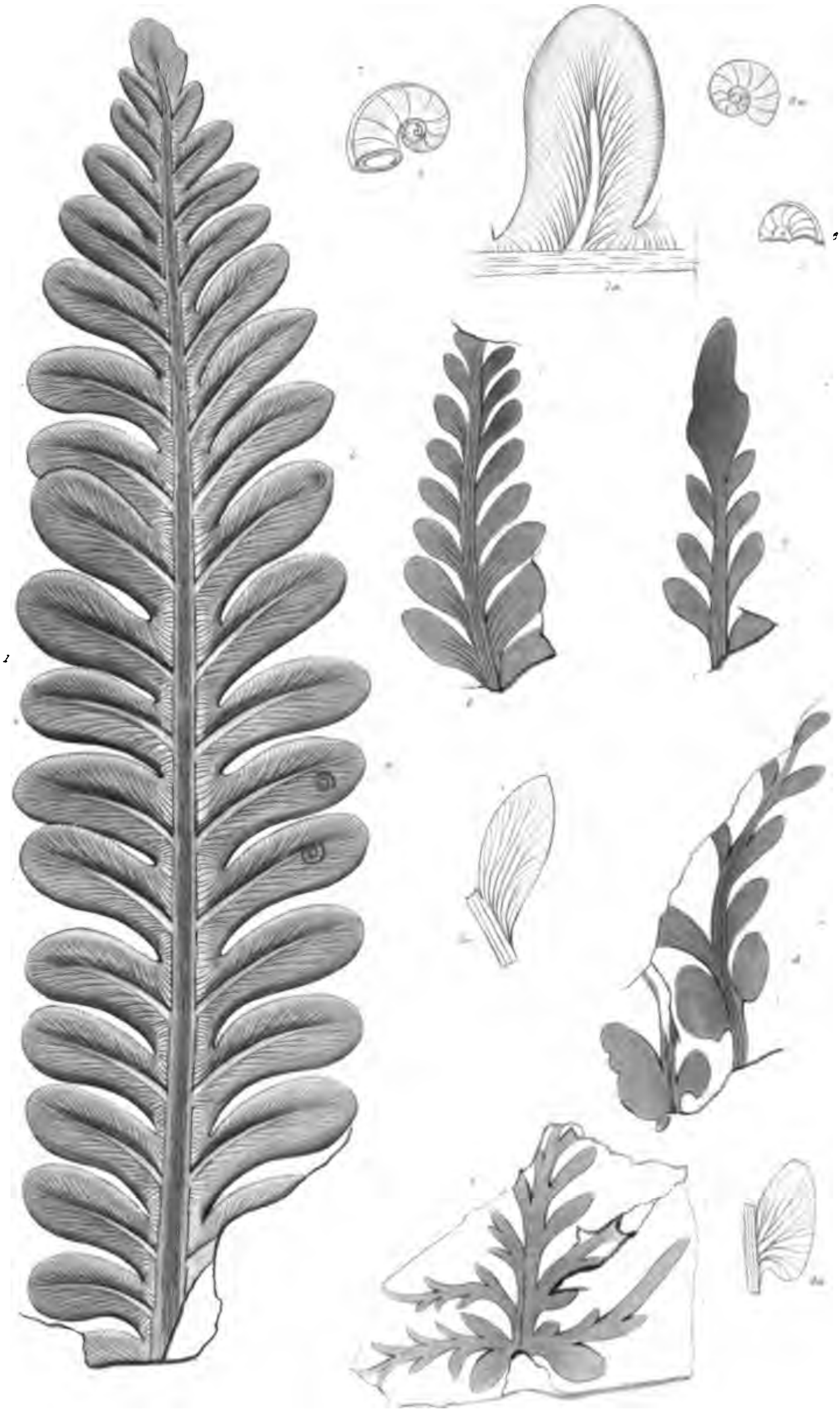
2 *a*, 4 *a*.	Enlarged leaflets of the same, showing nervation.	
Fig. 6, 6*a*, 6*b*.	GYROMICES AMMONIS, Gopp	462
	Enlarged 10 diameters.	

GEOLOGICAL SURVEY OF ILLINOIS

CARBONIFEROUS (Coal Measures) FOSSIL FLORA



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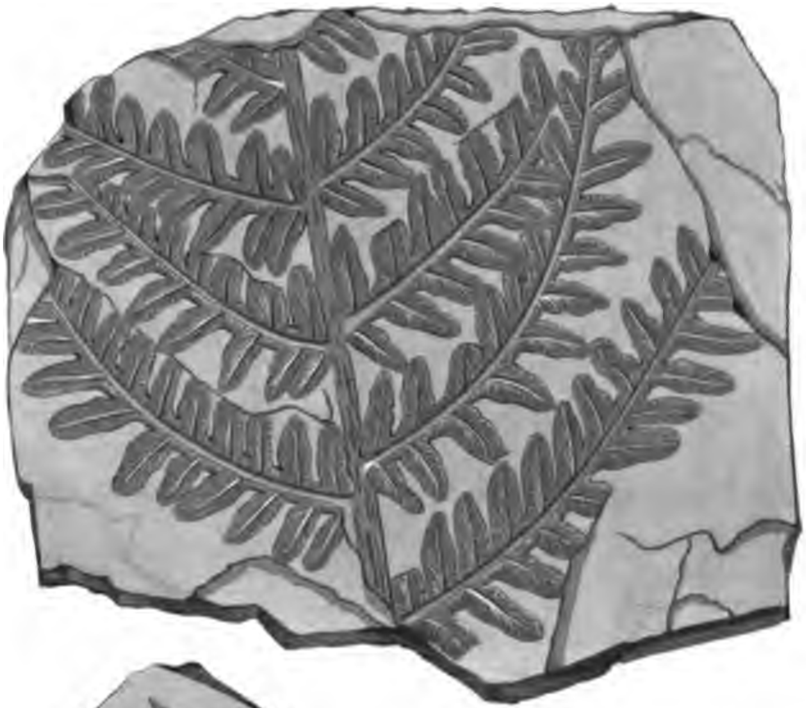

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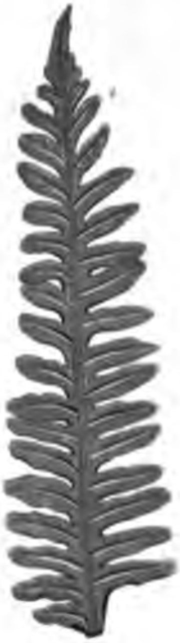

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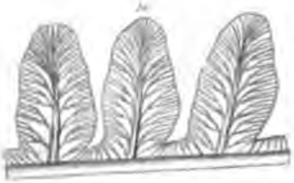

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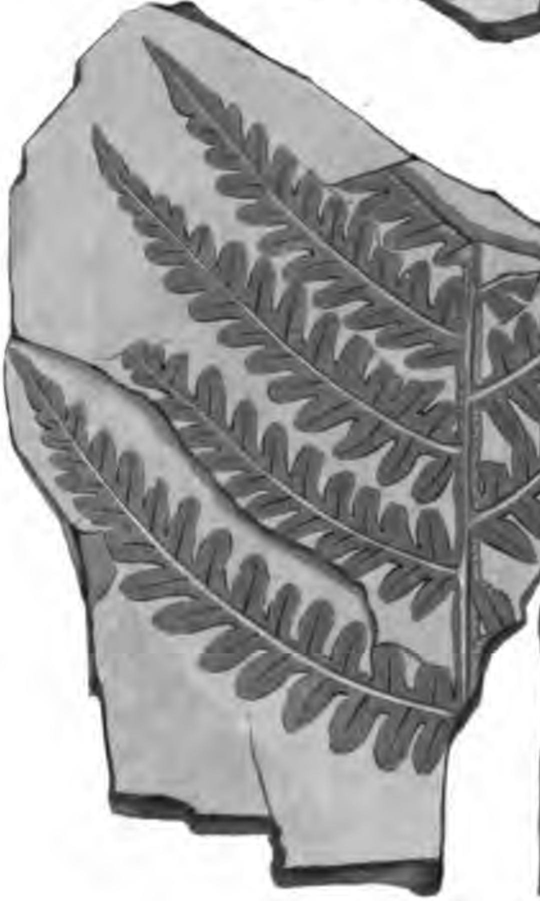

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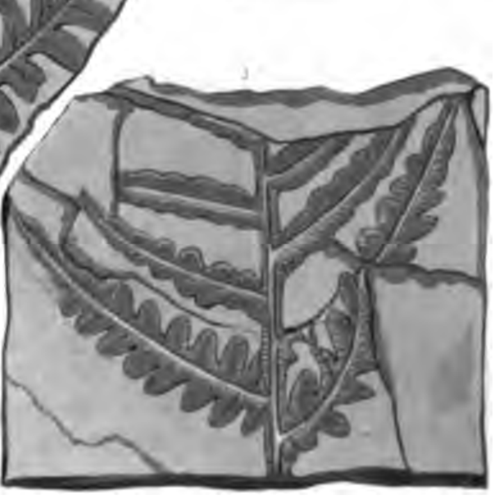

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Fig. 8.	**SELAGINITES CRASSUS**, Spec. nov.	446
Fig. 9.	**STIGMARIA EVENII**, Spec. nov	448

GEOLOGICAL SURVEY OF ILLINOIS

CARBONIFEROUS (Coal Measures) **FOSSIL FLORA**

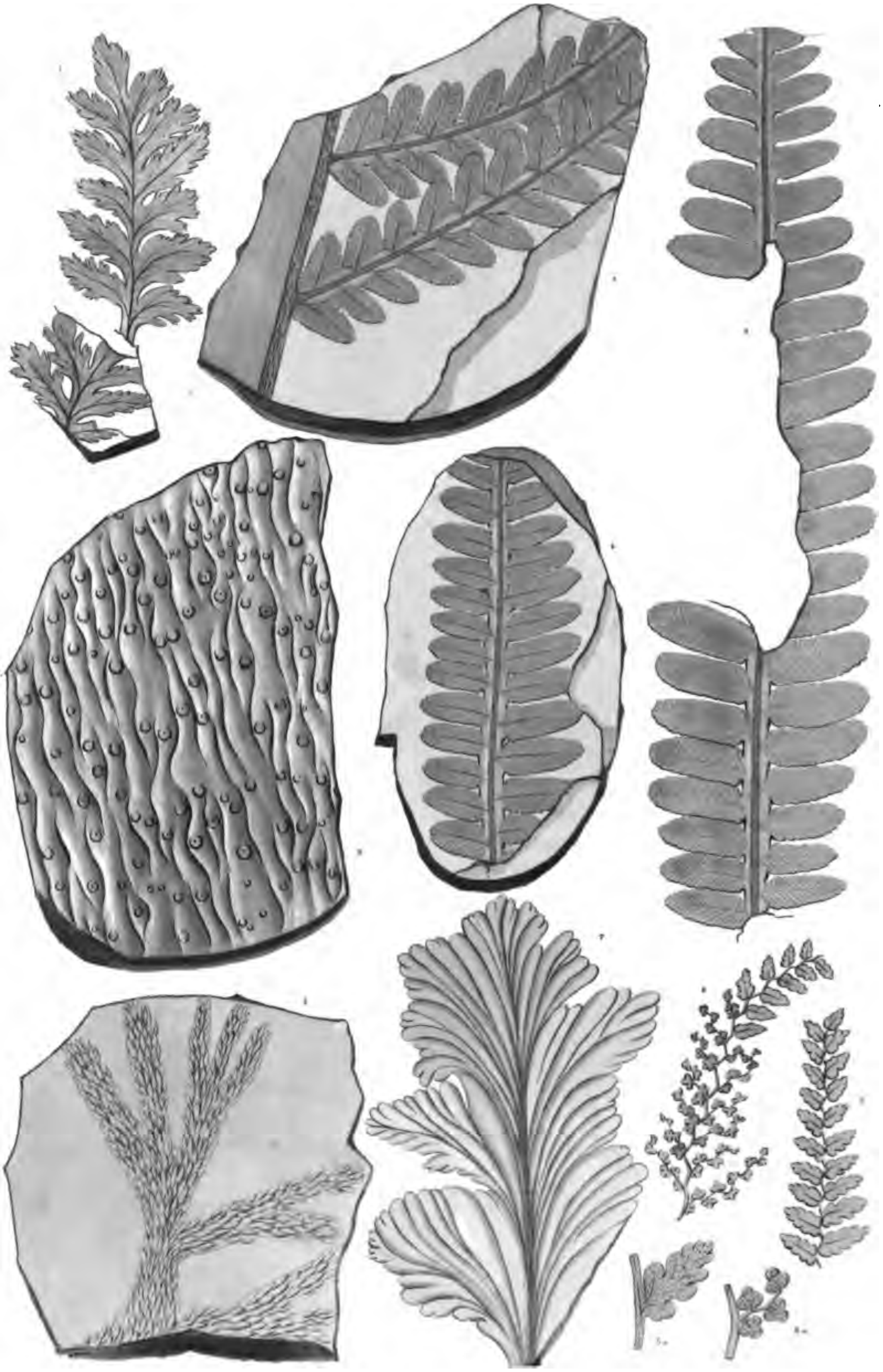

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PLATE XLI.

PAGE

Fig. 1. LEPIDOPHLOYOS OBCORDATUM, Spec. nov......................457

1 *a*, 1 *b*. Enlarged scales of the same.

2. Probably the same species; a specimen with scars, and deprived of scales.

2 *a*. Enlarged scar of fig. 2.

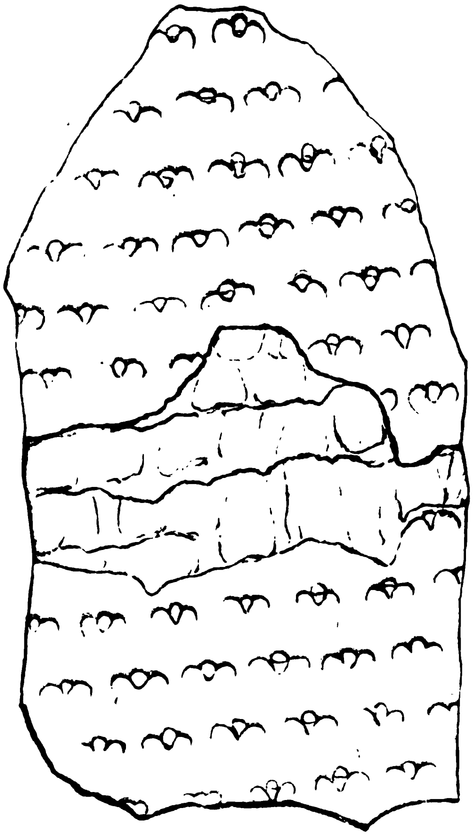
Fig. 3. SELAGINITES UNCINNATUS, Spec. nov..........................446

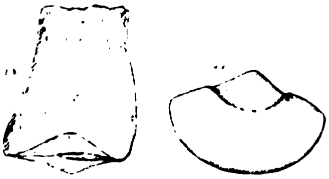
Fig. 4. SPHENOPTERIS PAUPERCULA, Spec. nov........................435

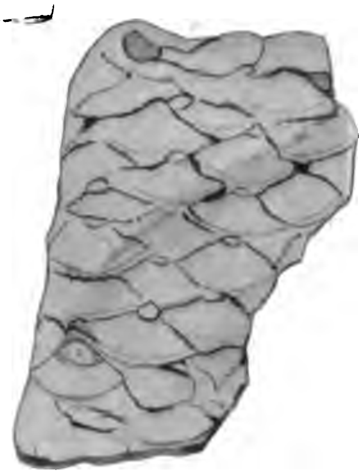
4 *a*. Enlarged leaflet of the same, showing nervation.

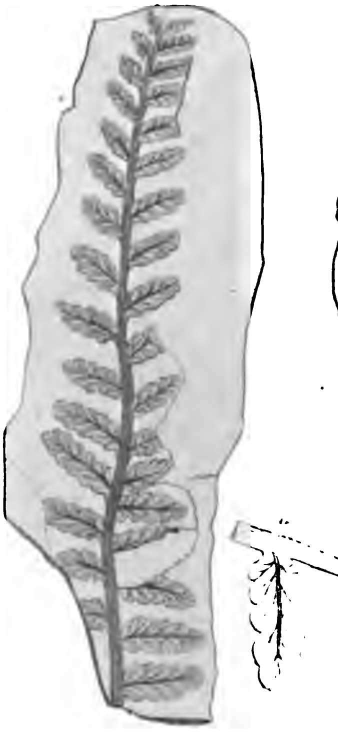
GEOLOGICAL SURVEY OF ILLINOIS

CARBONIFEROUS (Coal Measures) FOSSIL FLORA









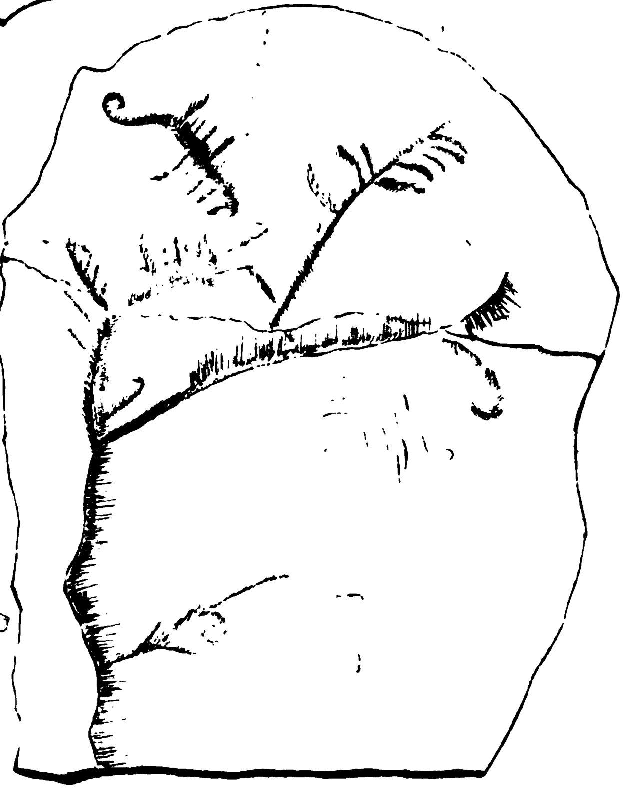


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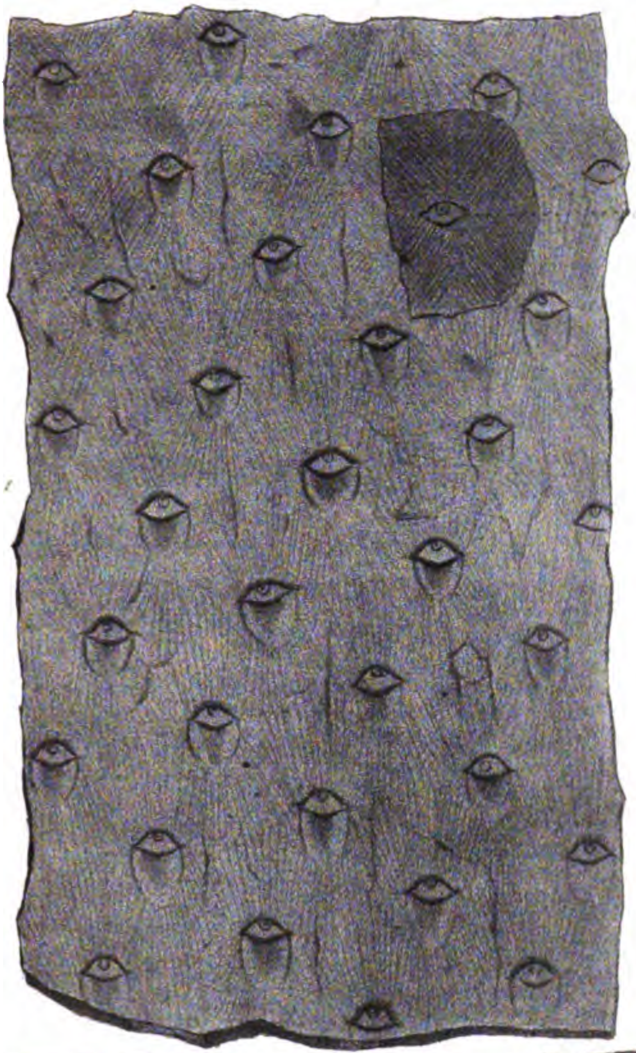
PLATE XLII.

		PAGE
Fig. 1–5.	SIGILLARIA MONOSTIGMA, Spec. nov............................	449

And various appearances of the scars on corticated and decorticated specimens.

GEOLOGICAL SURVEY OF ILLINOIS.

CARBONIFEROUS. (Coal Measures) FOSSIL FLORA.



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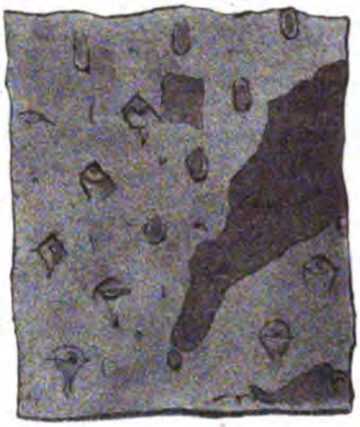

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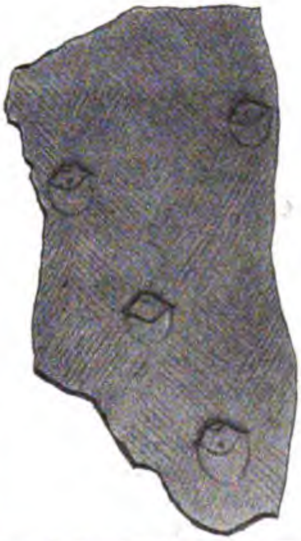

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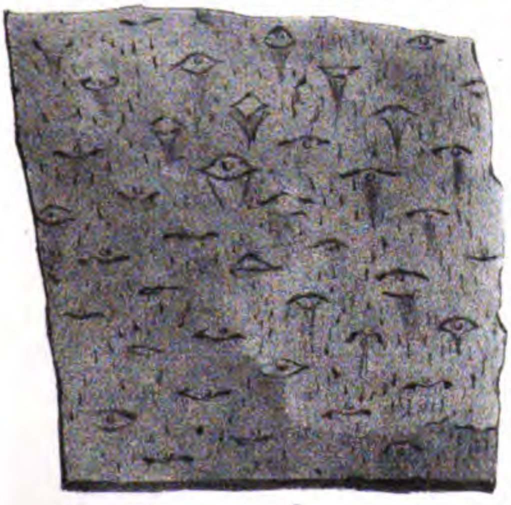

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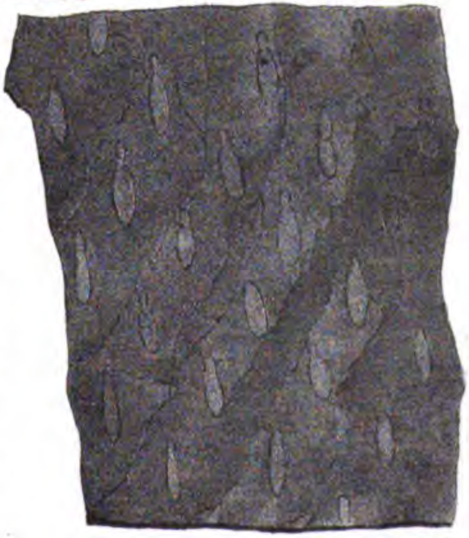

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PLATE XLIII.

		PAGE
Fig. 1.	SIGILLARIA MENARDI, Brgt. With scar of a branch.	450

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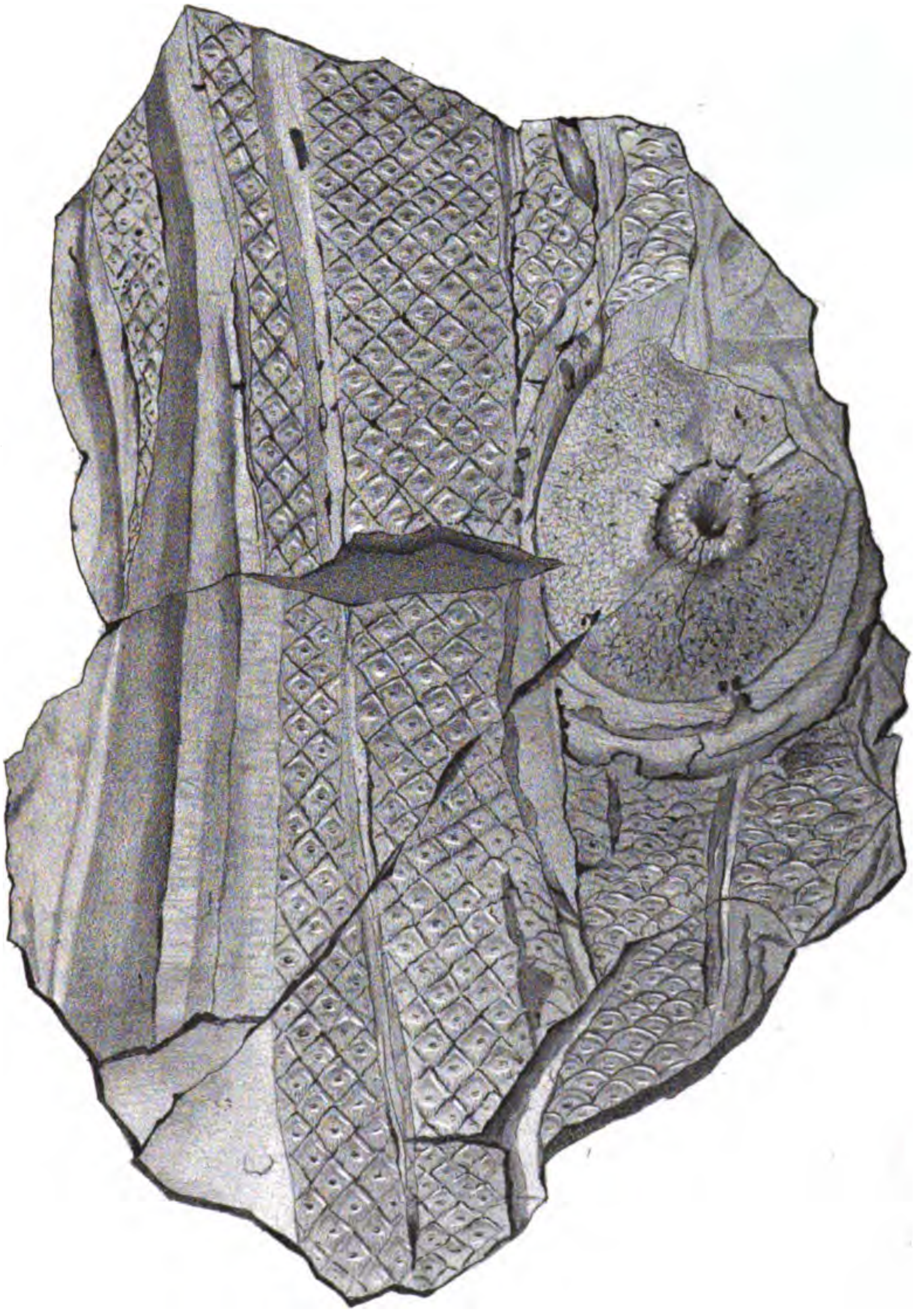
CARBONIFEROUS. (Coal Measures.) FOSSIL FLORA.



[illegible] A. H. Worthen [illegible] Western Engraving Co. Chicago

PLATE XLIV.

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Fig. 1–3.	**Lepidodendron obscurum**, Spec. nov	453
	Various appearances of bark, according to age.	
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Fig 6.	**Lepidodendron turbinatum**, Spec. nov	453
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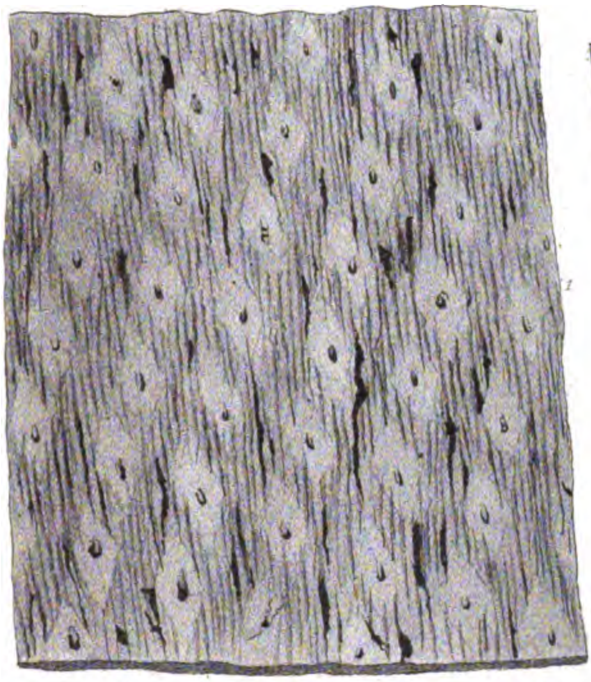
GEOLOGICAL SURVEY OF ILLINOIS.

CARBONIFEROUS. (Sub-Carboniferous & Coal Measures.) **FOSSIL FLORA.**



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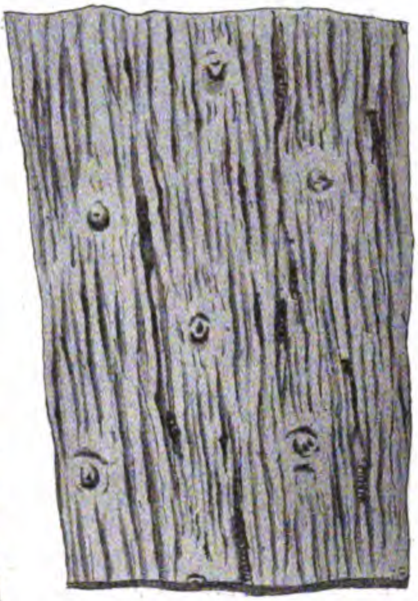

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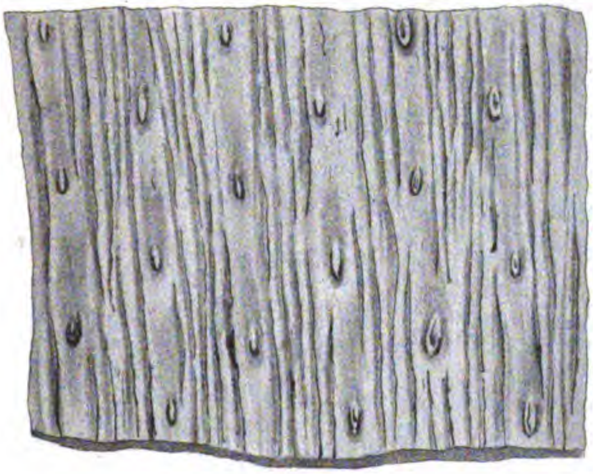

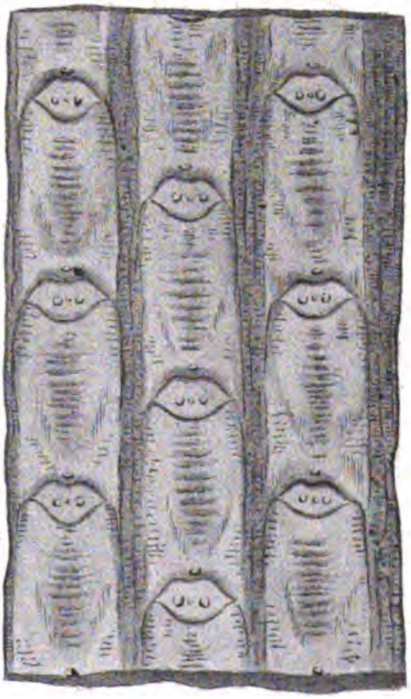

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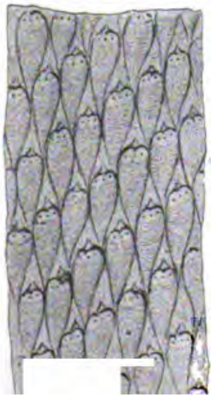

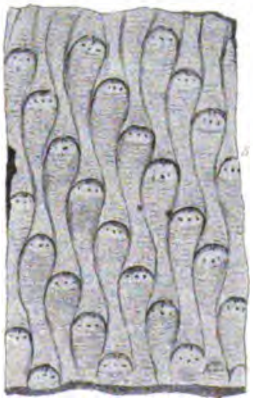

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PLATE XLV.

PAGE

Fig. 1–4. **LEPIDOSTROBUS PRINCEPS**, Spec. nov............................455

(Two-thirds of natural size.)

2–3. Cross section of the same, showing the position of the sporange-bearing axis, and of the upraised blades.

4. Pedicel of the sporange and its blade, or *Lepidophyllum princeps*.

Fig. 5. **LEPIDODENDRON SIMPLEX**, Spec. nov...........................454

Fig. 6–7. Leaves of *Lepidodendron*.

GEOLOGICAL SURVEY OF ILLINOIS.

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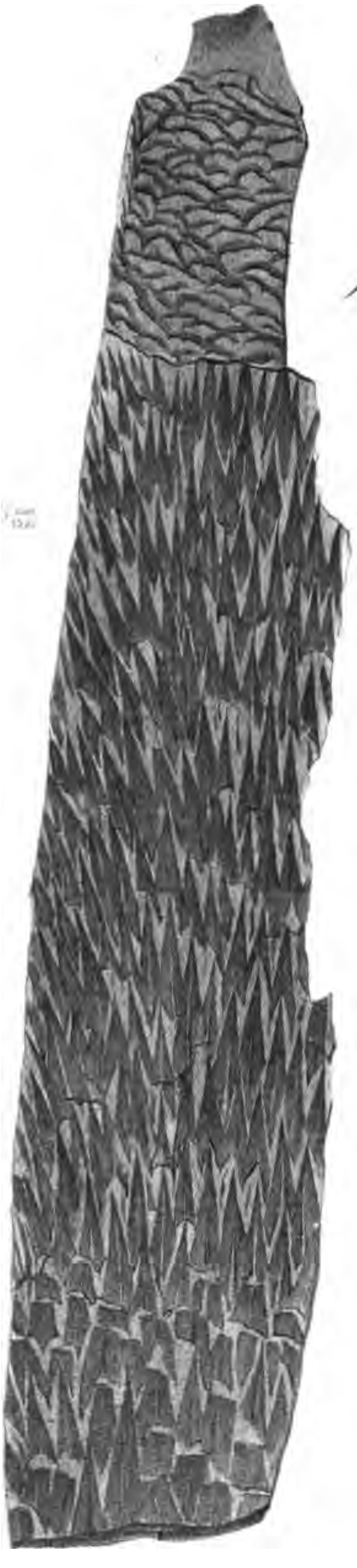

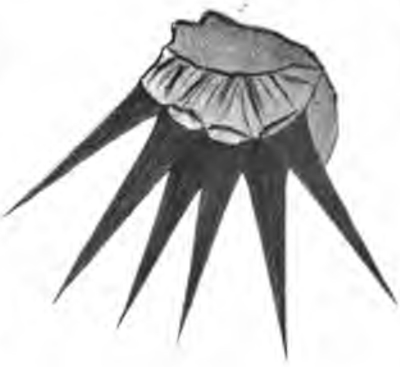

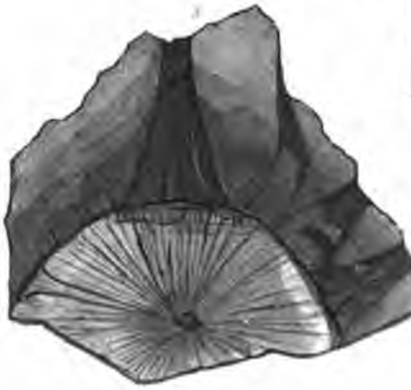

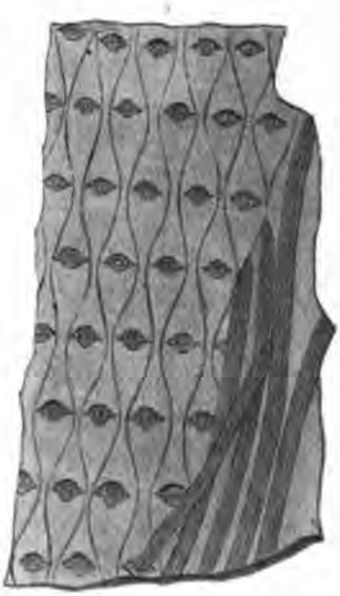

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PLATE XLVI.

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Fig. 1.	LEPIDODENDRON RADICANS, Spec. nov.	454
Fig. 2.	CARPOLITHES MULTISTRIATUS? Sternb.	460
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Fig. 6.	TRIGONOCARPUM ROSTELLATUM, Spec. nov.	460
Fig. 7.	CARPOLITHES FASCICULATUS, Spec. nov.	461

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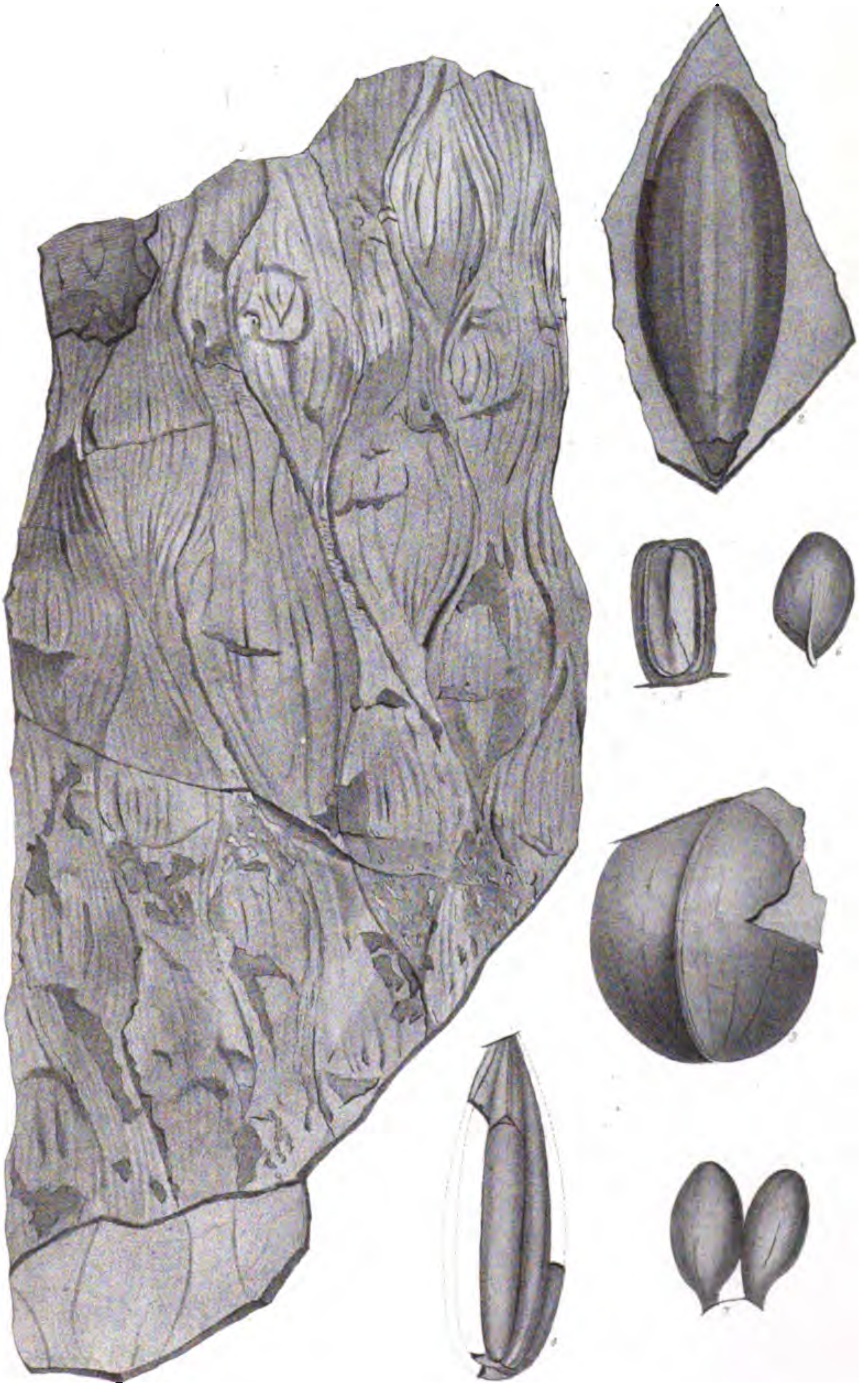

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Fig. 2.	LEPIDODENDRON DIPLOTEGIOIDES, Lsqx.	452

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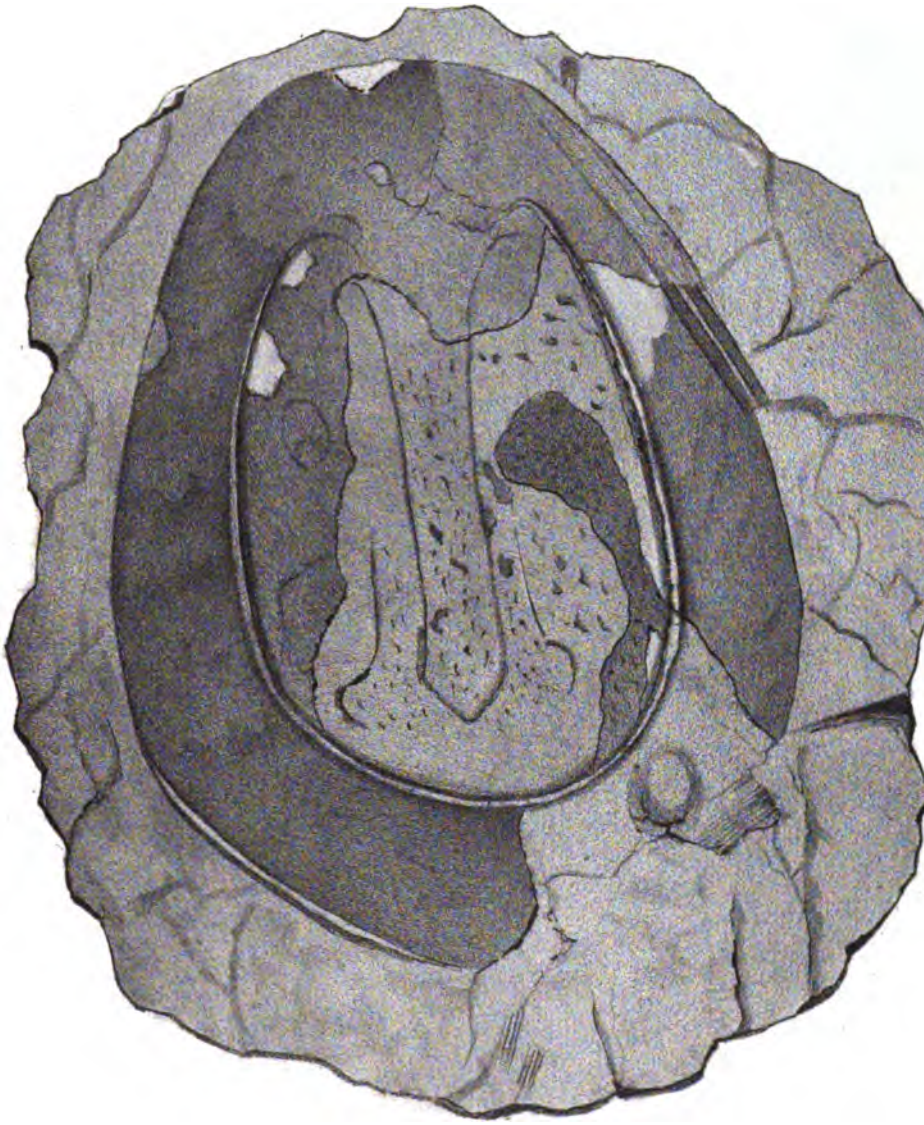

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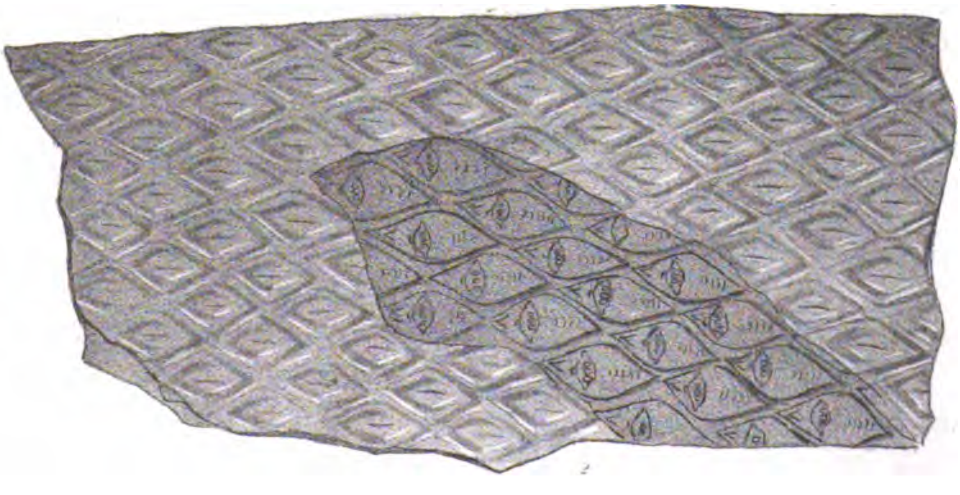

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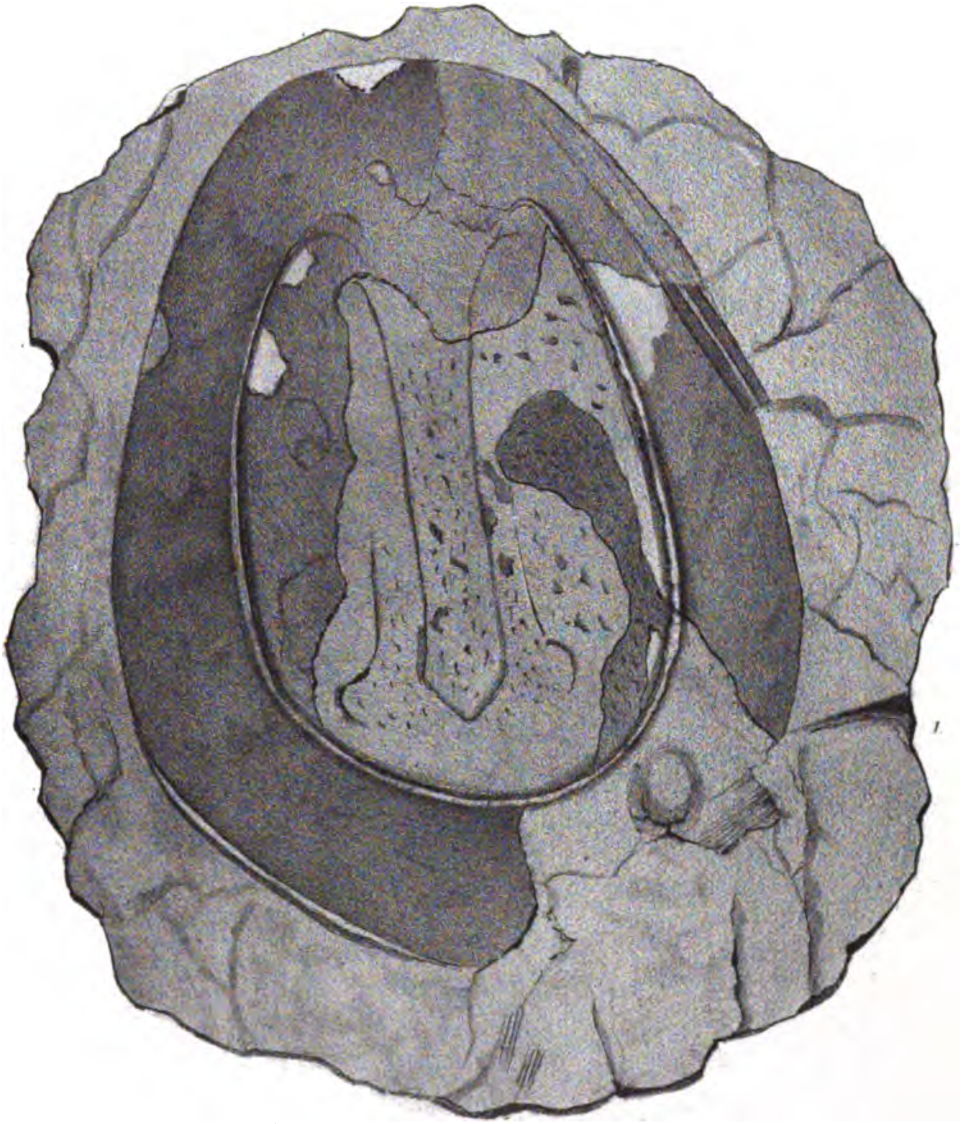

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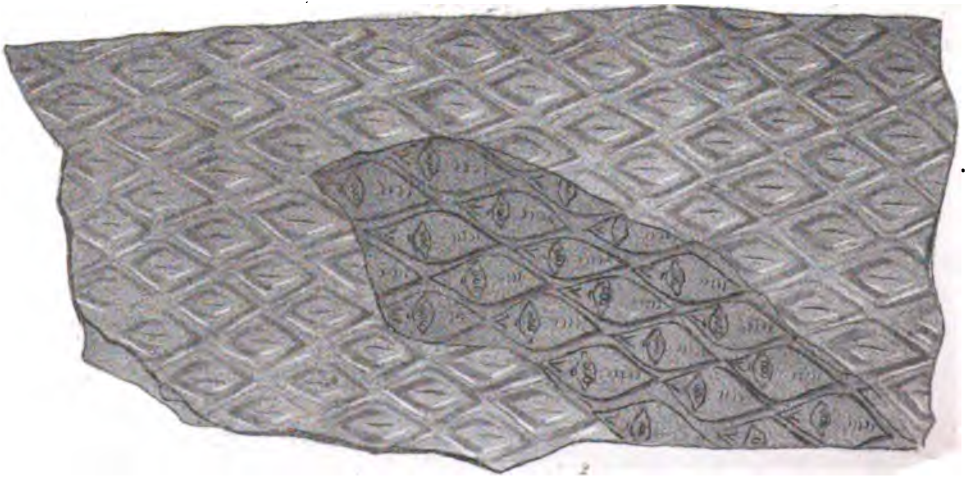

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PLATE L.

PAGE

Fig. 1. **CAULOPTERIS WORTHENII**, Spec. nov 459

(One-half natural size.)

1 *a*, 1 *b*. Bolsters of the same; natural size.

1 *c*. Cross section of the stem; natural size.

GEOLOGICAL SURVEY OF ILLINOIS.

CARBONIFEROUS. (Sub-Carboniferous) FOSSIL FLORA.